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OPERATIONAL SCENARIOS FOR THE INITIAL OPERATIONAL TEST AND EVALUATION OF THE RAH-66 HELICOPTER

by

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June 2002

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The United States Army is undergoing force structure and doctrinal changes to meet the evolving threats facing the nation. To fulfill operational requirements brought about by these changes, Army aviation is developing the RAH-66 Comanche. As a precursor to the Comanche being fielded in operational units, the aircraft must perform to standard during its Initial Operational Test and Evaluation (IOTE).

The Army must fashion the IOTE to ensure the Comanche meets the requirements of the future force. To do this, test scenarios must focus on placing the aircraft in environments and situations in which it will be expected to operate. Test scenarios must be kept technically and tactically sound to provide accurate and realistic information.

This thesis identifies scenarios which encapsulate future requirements brought about by the Army's migration to the Objective Force. The scenarios have been developed to test and evaluate operational effectiveness measures of performance. The scenarios reflect the early stages of FCS due to Comanche being the first system tested. As doctrine and the systems that comprise FCS continue to evolve, it is recommended to ensure the scenarios remain updated to reflect the most current information and equipment. Recommendations also include methods to alleviate resource constraints.

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OPERATIONAL SCENARIOS FOR THE INITIAL OPERATIONAL TEST AND EVALUATION OF THE RAH-66 HELICOPTER

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I. INTRODUCTION

A. BACKGROUND

As threats against the United States continue to change, Army leadership has identified a new direction the Army must take to meet them. To become more lethal, agile, and responsive, the Army is reshaping to meet the challenges of the 21st century. This reshaping, known as the Future Combat System (FCS), requires new equipment and systems with increased capabilities.

The first piece of the FCS will be the RAH-66 Comanche helicopter. This helicopter is designed to be a substantial improvement over aircraft in use today. As part of the acquisition process, the helicopter must go through an Initial Operational Test and Evaluation (IOTE). The IOTE places the aircraft in as realistic operational situations as possible, and determines how well the aircraft performs. This test and evaluation serves as the final exam to determine if the aircraft will go forward into full production and fielding within the service.

This thesis introduces potential scenarios to be used in the IOTE. The scenarios focus on incorporating new doctrine, and the Comanche's role in its execution. If the

Comanche is going to be the backbone of Army Aviation for the next 25+ years as planned, the aircraft must prove to fulfill the requirements put forth by the Army.

B. PURPOSE

The purpose of this thesis is to provide scenarios that can be used in the IOTE. The FCS not only requires new equipment, but also new doctrine describing how the FCS will fight. The scenarios included here incorporate this new doctrine in its current state.

C. SCOPE

This thesis provides background and discusses IOTE's role in the acquisition process. The scope of this thesis will be limited to IOTE scenarios that provide realistic operational events to test the Comanche's ability to perform as part of the FCS. Each scenario is fashioned to be comprehensive, testing as many operational effectiveness Measures of Performance as possible given the available resources.

D. METHODOLOGY

This thesis focuses on the requirements that the Comanche must exhibit to provide the capabilities the Army requires in its FCS aircraft. The analysis is based on literature research from books, theses, briefings, web sites, documents and discussions. The majority of research centers on the current Operational Requirements Document, Test and Evaluation Master Plan, Operational Mode Summary, and operational effectiveness Measures of Performance. These documents will be analyzed to determine their completeness in regards to capabilities that must be fielded to meet the needs of FCS. The findings of this research will be utilized to fashion scenarios for IOTE, which provide an accurate means to assess the Comanche's ability to perform as part of the FCS.

E. ORGANIZATION

In Chapter II, background information is provided on the Army's Future Combat System, dendritics, and aviation conceptual operations as part of the FCS. Chapter III describes IOTE scenarios. Included in each scenario is the operational effectiveness dendritic, shaded to reflect the

level of opportunity in that scenario to test each of the Measures of Performance. Chapter IV provides analysis of the IOTE scenarios, starting with the commonalities in MOP and capabilities tested. Following that, each scenario is analyzed individually, detailing the unique focus each scenario was designed to highlight. The chapter concludes with methods to minimize costs should funding constraints arise. Chapter V provides conclusions, recommendations, and suggested further studies.

II. BACKGROUND INFORMATION

A. INTRODUCTION

As the Army transforms to meet the threats of the 21st century, the resulting changes encompass the entire force. The Army's Objective Force not only calls for newer, more technologically advanced equipment, but also requires changes in organizational makeup and doctrine to most effectively employ this new equipment. This chapter defines the purpose of Initial Operational Test and Evaluation (IOTE), and provides a synopsis of the formulation of testing procedures, based upon the dendritic method. The chapter concludes with the future Concept of Operations (CONOPs) Army aviation envisions conducting as part of the future combined arms team.

B. INITIAL OPERATIONAL TEST AND EVALUATION.

The IOTE is a field test, under realistic operational conditions, of a production or production-representative system (or key component of such a system) to determine its operational effectiveness and operational suitability for use by typical users in combat or when otherwise deployed.

The Initial Operational Test environment is as operationally realistic as possible including realistic threat systems. Typical users operate and maintain the system under conditions simulating actual deployment conditions. [Ref. 1] Because of the increasing cost of conducting tests, testers and evaluators must be focused on the important and highly sensitive operational issues needed to ensure successful fielding of a new system. [Ref. 2]

These costs and operational issues become even more important for new systems, such as aircraft, that require extensive training of the operators. In most cases, the proficiency of the individuals employing the system dictates success or failure. Therefore, not only must tests be planned and executed to capture the data necessary to answer the right questions, users must be adequately trained to employ the system correctly.

Testers and evaluators have very different responsibilities in the IOTE process. The operational tester is the Army command or agency that plans, conducts and executes operational tests, including early user test and experimentation (EUTE), Force Development Test and Experimentation (FDTE), Initial Operational Test (IOT), and

follow-on operational test (FOT). The operational tester will provide Test Results (TRs) directly to the program manager and the Army System Acquisition Review Council (ASARC) or Interim Program Review (IPR) body. [Ref. 1] The operational evaluator is the Army command or agency that addresses the operational effectiveness and suitability of systems to be acquired by determining the degree to which the system's Critical Operational Issue and Criteria (COIC) have been satisfied. The operational evaluator will provide evaluation reports directly to the program manager and ASARC, IPR, or MAISRC review body. The operational evaluator will continuously evaluate all assigned systems. [Ref. 1] More simply, operational testers will put the system through its paces conducting the test, operational evaluators take the information derived from the tests, and evaluate it to determine how the system performed.

C. DENDRITICS

A dendritic is a tool to develop and see relationships. It is similar to a tournament playoff ladder except that it is reversed; it starts with a single line and then separates into more detailed levels as one decomposes the elements of the structure. The technique

results in a tree-like structure with several branches emanating from each juncture. [Ref. 3] The process of creating the dendritic facilitates the identification of critical issues, Measures of Effectiveness (MOE), Measures of Performance (MOP), and data requirements. The entire dendritic structure is a series of questions that start with the issue, and flows down to potentially hundreds of data requirements. The data requirements then facilitate developing the test plan for a system. By identifying the data requirements necessary to answer the questions posed in the dendritic, testers can formulate tests to capture the necessary data.

Critical issues are stated as broad questions, and defined as any aspect of the proposed system's capability that must be tested in order to determine the system's operational effectiveness, suitability, and survivability. Operational effectiveness is defined as the overall degree of mission accomplishment of a system when used by representative personnel in the environment planned or expected (for example, natural, electronic, threat, and so forth) for operational employment of the system considering organization, doctrine, tactics, survivability,

vulnerability, and threat (including countermeasures; initial nuclear weapons effects; nuclear, biological, and chemical contamination threats). Operational suitability is the degree to which a system can be satisfactorily placed in field use with consideration given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistic supportability, and training requirements. Finally, operational survivability is the capability of a system and its crew to avoid or withstand a man-made hostile environment without suffering an abortive impairment of its ability to accomplish its designated mission. [Ref. 1]

These issues then form the basis of the Test Plan. [Ref. 3] There will be at least one dendritic for each of these three areas. For example, the issue identified for use in the Comanche dendritic for effectiveness questions, "How well does the Comanche equipped unit conduct operations?" This subjective question serves to start the dendritic process, but will have to be further broken down before it can be answered.

After identifying issues the test plan must answer, MOEs are formulated to begin to find the answers. MOEs are

defined as a measure of operational success that must be closely related to the objective of the mission or operation being evaluated, for example, kills per shot, probability of kill, effective range, etc. A meaningful MOE must be quantifiable and a measure to what degree the real objective is achieved. [Ref. 4] Evaluators must also ensure that MOEs remain relevant, complete, and precisely defined. Of crucial importance as well is to keep the MOEs mutually exclusive.

MOEs are further broken down into MOPs. These are measures of lowest level of performance representing subsets of MOEs. Examples are speed, payload, range, time on station, frequency, or other identifiable objective performance features. [Ref. 4]

The dendritic process does not end with MOPs however. The final two levels of breakout required to answer the MOPs are defined as data elements, and data collection requirements. Data elements are the objective, numerical, or yes/no questions, which when pooled together, answers MOPs. The base of the dendritic sequence is the data collection requirement. Data collection requirements are those items that can be collected at a single location, and generally requires no judgment on the part of the data

collector. [Ref. 3] These data collection requirements, when answered, provide the necessary information to work your way from right to left on the dendritic, enabling testers to gather the necessary data requirements to answer MOPs, which in turn should answer MOEs, which in turn answers the issue. Figure 1 clarifies what is a logical and intelligible progression.

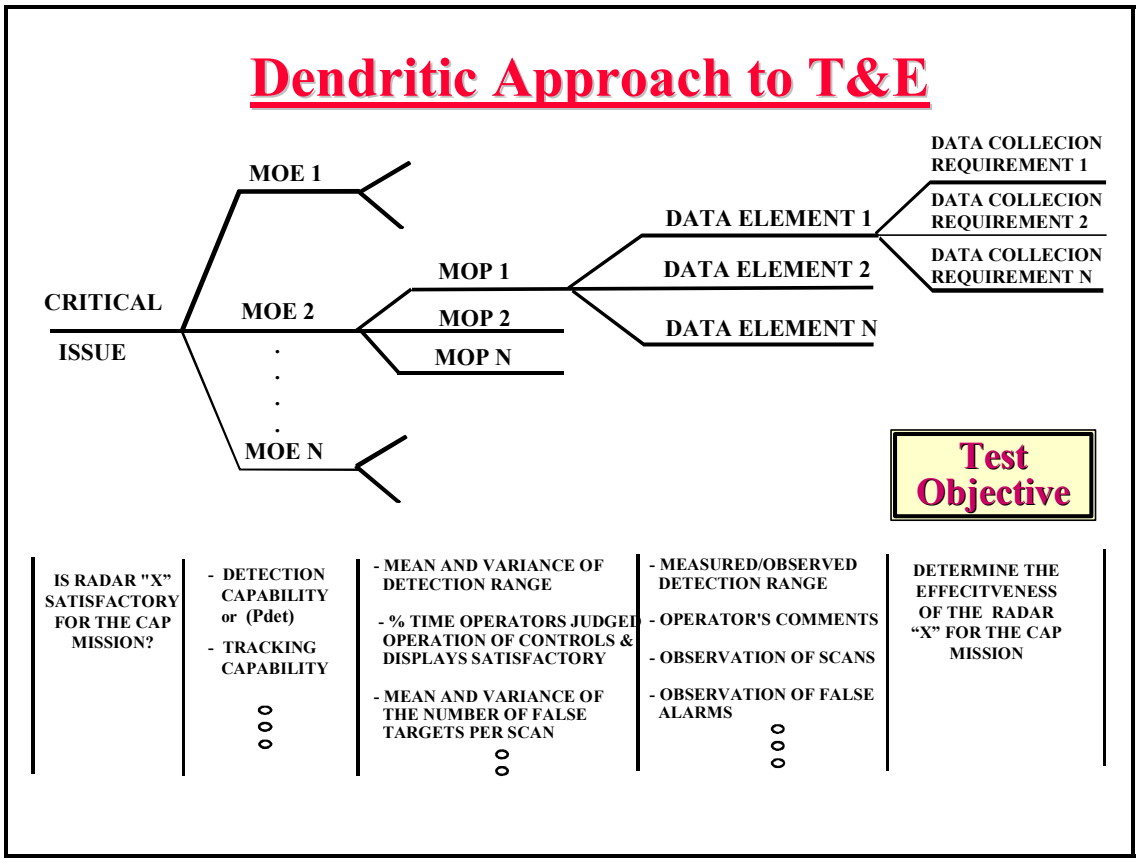

Figure 1. Dendritic Approach to Test & Evaluation

Figures 2 and 3 show the current operational effectiveness dendritic for the RAH-66, to include additional MOPs acknowledging the Comanche's requirement to interoperate with off-board sensors. [Ref 9]

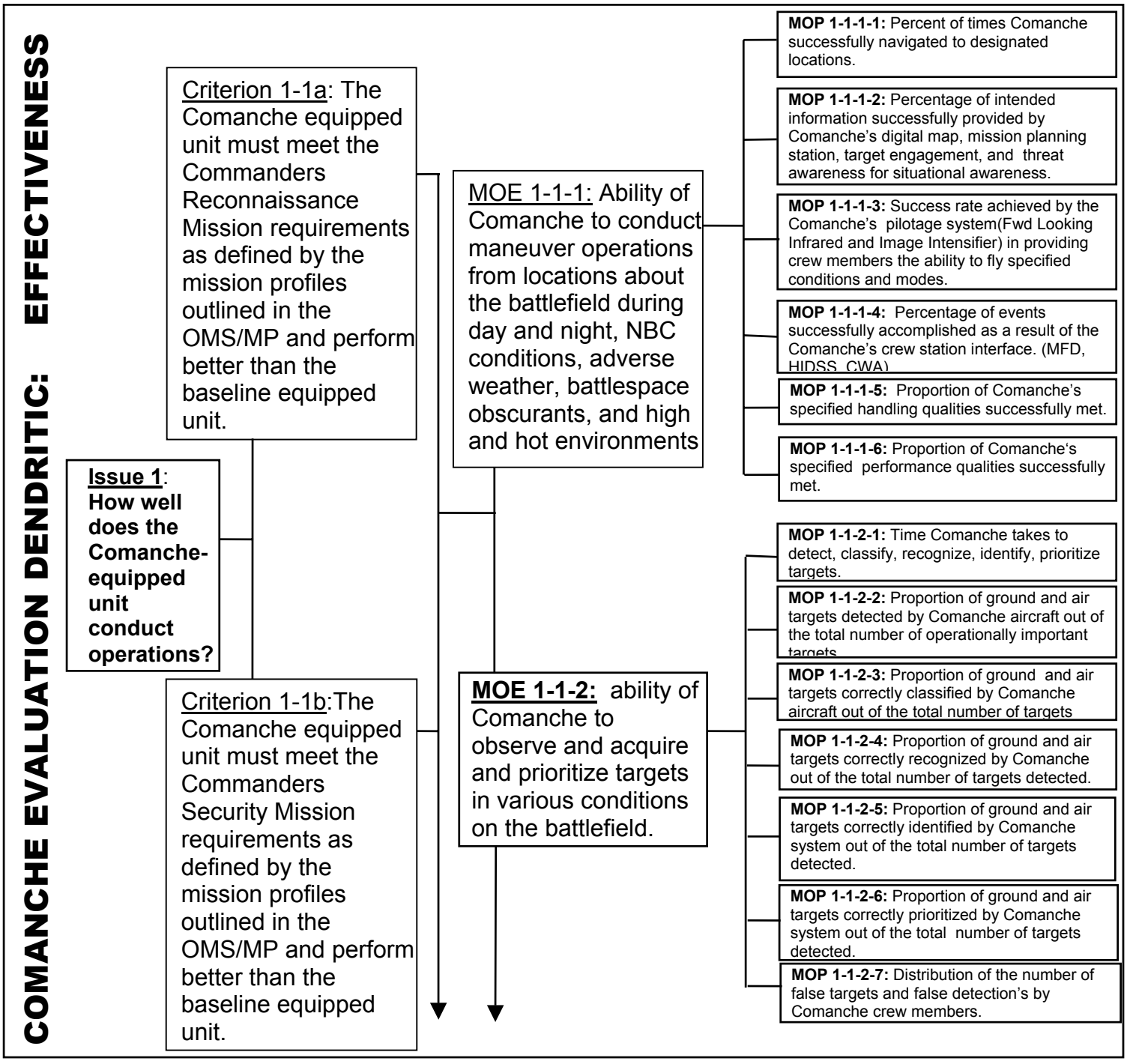

Figure 2. Comanche Operational Effectiveness Dendritic

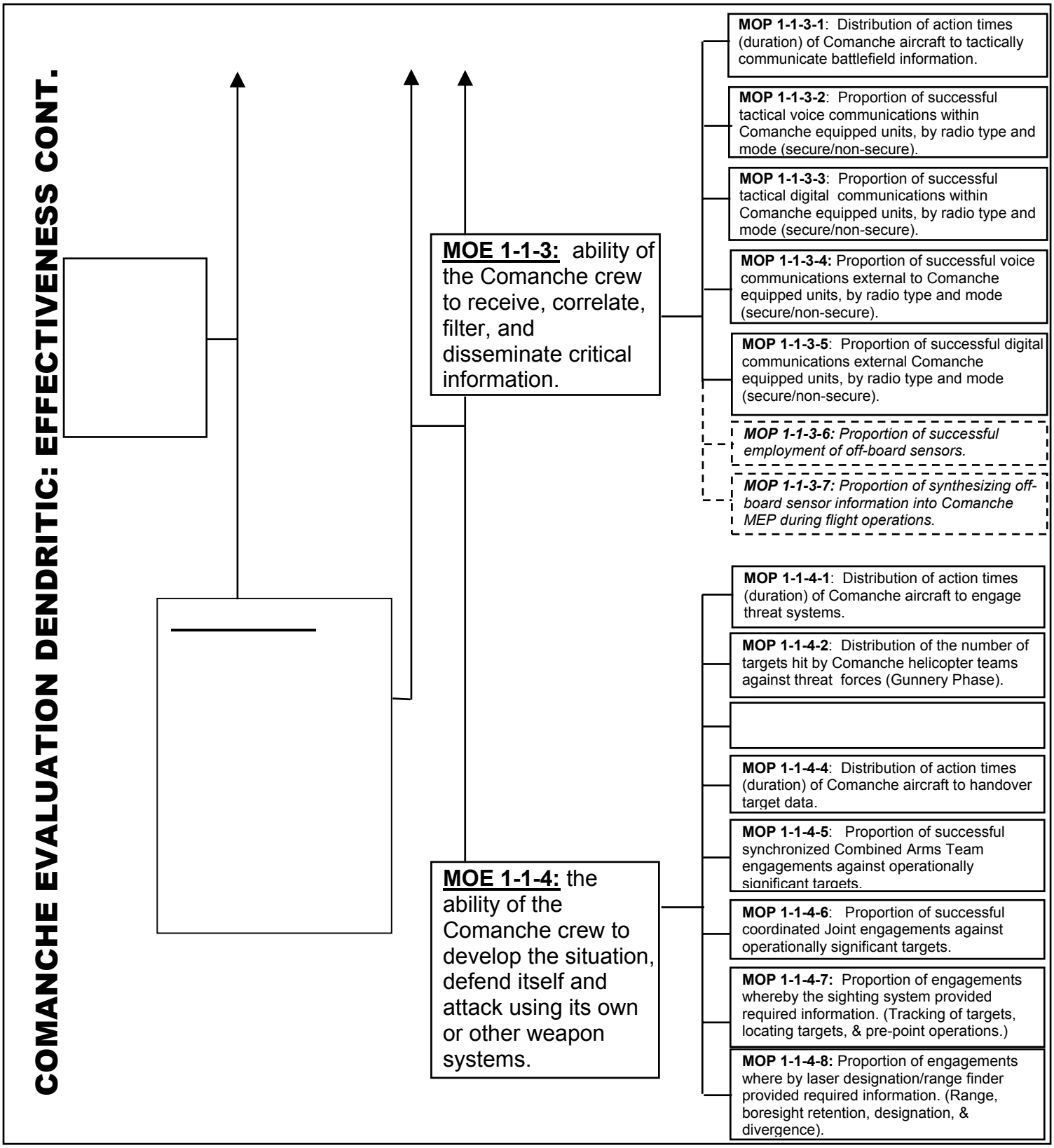

Figure 3. Comanche Operational Effectiveness Dendritic Cont.

D. THE ARMY'S FUTURE COMBAT SYSTEM (FCS)

The Future Combat System will be a multi-functional, multi-mission re-configurable system of systems to maximize joint inter-operability, strategic transportability and commonality of mission roles including direct and indirect fire, air defense, reconnaissance, troop transport, counter mobility, non-lethal and C2 on the move. The FCS is envisioned to be an ensemble of manned and potentially unmanned combat systems, designed to ensure that the Objective Force is strategically responsive and dominant at every point on the spectrum of operations from non-lethal to full-scale conflict. [Ref 5]

The Future Combat Systems solution will not be a single vehicle system. While it may turn out that the functional and tactical requirements for FCS can be achieved by a single vehicle system or platform, it is equally reasonable to think that the requirements may best be met by one or more vehicle system sets. The FCS could be a distributed network centric system with all of the functionality necessary to be successful on the modern battlefield distributed among multiple vehicle elements whose capabilities sum to the capabilities necessary for victory in all forms of combat. This versatility will be

realized through emphasis on an open architecture system concept, with an easily upgradeable and tailorable design approach to enable the system to engage in different missions as needed.

A vital aspect of FCS will be the capability to rapidly project a dominant force anywhere in the world within days. This strategically deployable, tactically superior and sustainable force will provide a quick reaction capability for future conflicts. To accomplish this, the objective of the Future Combat Systems effort is to develop lightweight (no individual element greater than 20 tons), overwhelmingly lethal, strategically deployable, self-sustaining and survivable combat and combat support forces, systems and supporting technologies for the 2012-2025 timeframe and beyond. Another crucial capability which the FCS force must incorporate, is the ability to gather and exploit information dominance to develop a common, relevant operating picture and achieve battlespace situational understanding between the entire air-ground team. [Ref. 5]

E. ARMY AVIATION CONOPS AS PART OF FCS

In developing IOTE requirements for the Comanche, it is necessary to formulate scenarios based upon doctrine with which the aircraft will be employed. The exact doctrine has not been finalized, but one theme that pervades all drafts to date is aviation assets taking on a more critical and inclusive warfighting role. The Army's Training and Doctrine Command (TRADOC), has developed a draft set of CONOPs (Concept of Operations) which Army aviation will need to accomplish as part of the objective force. The goal of these updated missions focuses on fully integrating aviation into all operations of the air-ground team. To accomplish this goal, TRADOC has identified six missions which aviation must accomplish as part of the combat team. These are: reconnaissance, mobile strike, close combat with ground forces, division air assault of a battalion, multi-modal operational maneuver, and battle command on the move. [Ref. 6] Many of these new missions encompass much of what Army aviation has been called on to do in the past, but demand increased capabilities. Future missions will require Army Aviation to operate across greater frontages and deeper into enemy areas. These

missions will also demand a level of interoperability with Army ground forces, as well as other services' forces, to a greater extent than ever before. Scouts of the future require better sensors to detect threats from safer distances and low observable technology to defeat infrared radiation seeking and radar guided air defense. Also crucial are communications systems to talk at the greater ranges at which Army Aviation will operate. [Ref.6]

1. Reconnaissance

On the surface, this "new" mission has been conducted by Aviation, particularly Air Cavalry, for decades. In fact, the underlying critical tasks required of aviation as part of the team conducting reconnaissance for the objective force remain the same: gain and maintain enemy contact, orient on the reconnaissance objective, report rapidly and accurately, retain freedom to maneuver, develop the situation, and ensure maximum reconnaissance assets are forward, have not changed at all. [Ref. 7] Technological enhancements, however, improve the manner and capabilities with which the Army, and other services, can conduct reconnaissance.

To be successful, Army aviation must leverage these new technologies into a more effective platform with which to implement the fundamentals. To accomplish this, according to TRADOC, new aircraft must be able to detect, identify and affiliate targets, maintain communications with all members of the air-ground team, develop and share the common picture of the battlefield, and have the ability to dynamically re-task sensors. [Ref. 6] Dynamically re-tasking sensors involves operators forward in the vicinity of the enemy and conducting missions in aircraft, having the ability to shift non-organic sensors to new objectives, from their own cockpit. An example of this would be a aeroscout deployed forward conducting a zone reconnaissance, shifting a Tactical Unmanned Aerial Vehicle (TUAV) from its current Named Area of Interest (NAI), to another location to cover gaps or an unexpected event, such as losing an aircraft to enemy fire.

All of these requirements lead to the ultimate purpose of reconnaissance: provide the commander timely and accurate information to take decisive action at the time and place of his choosing. Future aviation systems will be called upon to accomplish this to a greater extent than any system currently fielded by the Army.

2. Mobile Strike

The purpose of mobile strike is to combine ground based fires, attack aviation, and joint assets to mass effects in order to isolate and destroy key enemy forces and capabilities. Mobile strike also serves to shield friendly forces as they maneuver out of contact. [Ref. 6]

To accomplish this mission, aviation assets are placed as needed throughout the battlespace, most likely past the Forward Line of Troops (FLOT). However, should the battlespace prove to be non-contiguous, aviation assets must maneuver wherever needed. This puts a human in the decision and execution loop who is in position to make timely decisions. Additionally, being in the proximity of the enemy enables better synchronization of direct sensors and fires. The ability to quickly recognize gaps in the zone of reconnaissance, re-task an off board sensor to fill the gap, or maneuver the aircraft to fill the gap itself, will prove invaluable. Conversely, if the reconnaissance objective is detected, having a human in the loop forward also enables the retasking of sensors to provide redundancy. Redundancy is crucial to maintaining contact with the enemy should they be on the move in difficult

terrain. Likewise, as with the case of having a gap in the reconnaissance effort, the aircraft can maneuver in this instance to become directly involved in gaining contact with the enemy force. [Ref. 6]

Besides the ability to better synchronize sensors, there will also be the ability to better synchronize fires. Putting a human forward with the ability to control effects after munitions are in flight, and control the terminal effects in the Engagement Area (EA), will greatly improve the FCS' lethality. Another benefit will be the ability to quickly assess the success of the strike. If the strike accomplishes the desired endstate quickly, subsequent strikes can be redirected to other targets, saving ammunition. On the other hand, if the volley of fire does not accomplish the mission, additional assets can be brought to bear until the desired outcome is met.

To accomplish this envisioned mobile strike, aviation assets will be required to detect, identify, and affiliate targets, have the capability for Beyond Line of Sight (BLOS)/Non-Line of Sight (NLOS) communications, and have the ability to dynamically re-task sensors. Also required will be the ability to direct/employ precision weapons, and to share a common architecture with the Joint/Army fire

support system. The most crucial element to success, however, is the ability of aviation assets to share a common operating picture with all the members of the air-ground team. [Ref. 6]

3. Close Combat with Ground Forces

The purpose of the close combat with ground forces mission is to conduct decisive, integrated air-ground operations to close with and destroy the enemy through fire and maneuver or tactical assault. The key to success in this case is for aviation assets to stay in close support of the ground forces in contact with the enemy. Airborne platforms are well suited for this due to their superior ability to fire and maneuver utilizing terrain and standoff capabilities. These same abilities also enable aviation systems to stretch the enemy, bypassing his strengths to attack weakness, presenting him with multiple/simultaneous dilemmas from which he cannot escape. Similar to this is the ability to extend the tactical reach of maneuver forces. Commanders are able to engage the enemy with direct fires, or with human in the loop indirect fires, at much greater ranges due to the airborne assets superior

effective fire range and vantage point. With the ability to move rapidly, virtually unimpeded throughout the battlespace, in conjunction with its long-range accurate fire, aviation is ideally suited to augment success or shore up weakness.

Another advantage afforded the combat team in this scenario is a superior command and control platform with which to control the Operational Tempo (OPTEMPO) of the fight. With superior connectivity to multiple sensors on the battlefield, coupled with the ability to maneuver directly to gain eyes on the critical point, envisioned aviation assets would be the ultimate platform from which to gather critical battlefield information for the close fight. Crucial to managing the close fight is the ability to synchronize all available fires on the enemy force. This calls for superior situational awareness, provided by a common operating picture between all friendly elements, as well as the ability to communicate with those elements. All of these parameters are designed into Army aviation's future scout/attack aircraft, the Comanche. [Ref. 6]

4. Division Air Assault of a Battalion

The purpose of this mission is to allow battalion-size mounted or dismounted elements the ability to extend tactical reach, negate the effects of terrain, seize key nodes, attain surprise, and dislocate or isolate the enemy. To accomplish this, friendly forces would ingress multiple routes to multiple Landing Zones (LZ). Obviously scout/attack aircraft would not accomplish the lifting of personnel or equipment, but still are absolutely critical for this CONOPs.

Lift aircraft, by their design, do not carry much in terms of firepower. For this reason, air assault missions employ scout/attack aircraft to provide enroute, as well as LZ security. Scout/attack aircraft, as part of providing LZ overwatch, also provide guidance for indirect fires if needed. Future systems will have the ability to provide better security due to their ability to tie into the entire gamut of sensors deployed across the battlespace. Instead of being limited to providing immediate security as far as their organic sensors can range, future systems can tap into or direct assets such as Unmanned Aerial Vehicles (UAVs), or other service's assets like JSTARS. Once enemy

forces are detected by any of these sensors, scouts in the future aviation platform will be well equipped to employ joint assets, or direct fire, to destroy the enemy.

Tacit to this mission as well is the ability to quickly transition to the close combat CONOP once ground forces are positioned after drop-off. Perhaps most critical, however, is having a human in the loop forward to quickly assess surprises/opportunities, and take appropriate actions based on the situation.

As part of the FCS air-ground team conducting a division air assault of a battalion, the future scout/attack aircraft will need to possess superior capabilities. Namely, Beyond Line of Sight (BLOS)/Non-Line of Sight communications (NLOS), the ability to share the red/blue Common Operations Picture (COP) with all the air-ground team members, as well as the ability to dynamically re-task organic and non-organic sensors. Additionally, the rapid detection, identification, and affiliation of targets, along with the capability to synchronize joint and organic fires of the air-ground team are required. [Ref. 6]

5. Multi-Modal Operational Maneuver

The purpose of multi-modal operational maneuver is to expose the entire enemy Area of Operations (AO) to direct attack, in order to separate echelons, prevent massing, and deny enemy reinforcement. By attacking and disrupting his entire framework of operations, and breaking his forces into disjointed pieces, friendly elements will be able to dictate the terms of engagement. History has shown that the force able to fight on its own terms is rarely defeated.

The future combat system will implement this CONOP by conducting both air and ground maneuver. The air portion will conduct advance reconnaissance to gain and maintain situational understanding in the AO. At the appropriate time, aviation assets will synchronize joint and organic fires to shape the battlespace to create a favorable environment. Multiple operations such as this will take place throughout the battlespace simultaneously. The enemy will be forced to react to attacks throughout his own AO, against command and control, logistics, as well as combat forces. Forcing him to react does not allow him the opportunity to conduct coordinated attacks of his own.

The requirements for aviation systems to conduct this mission mirrors the requirements from the CONOPS described earlier in this chapter:

- BLOS/NLOS communications
- Capability to dynamically re-task sensors
- Capability to detect, identify, & affiliate targets
- Capability to synchronize joint and organic fires
- Common/shared red/blue COP with all members of the air-ground team.

6. Battle Command on the Move

The purpose of battle command on the move is to provide command and control (C2) for the air-ground team forward, untethered to an operations center if needed. When the situation dictates, the Comanche must be equipped to provide the commander the necessary tools to command and control the air-ground team as a primary mission. [Ref. 8] This is currently an incredibly difficult endeavor to conduct successfully for larger fighting forces from mobile facilities.

To effectively conduct C2 at battalion and higher levels, leaders must have a thorough understanding of more than friendly and enemy force dispositions. They must also have access to BDA, friendly logistics status, common combined arms graphics, … incredible amounts of information to collect, analyze, and develop. The information processing requirements are so great that current practice requires a fixed Tactical Operations Center (TOC), with a large staff, to handle it all. The future forces' capability to readily share information, creating a robust common operating picture, lessens the need for reliance on the TOC. The optimal command and control scenario remains a secure location out of contact, with real time information feeds, providing total situational awareness to a commander with a complete and knowledgeable staff to aid in decision-making. However, if the situation dictates, the Comanche should afford the force a mobile operations center capable of directing the air-ground team for short durations.

The Comanche will have to accomplish the following to successfully conduct battle command on the move:

- Orchestrate sensors to develop the situation
- Direct maneuver to positions of advantage, increasing agility and mobility of the force

- Develop and share COP with all members of the air-ground team
- Issue and receive fragmentary orders (FRAGOs) with combined arms graphics
- Maintain communications with all members of the air-ground team
- Synchronize fires, maneuver, and tactical assault on objective for decisive operations. [Ref. 6]

The system requirements to carry out these tasks continue to mirror those of the other CONOPS. The most critical requirement to conduct Battle command on the move will be BLOS/NLOS communications.

F. SUMMARY

The Army requires new aircraft to fully accomplish its future missions of reconnaissance, mobile strike, close combat with ground forces, division air assault of a battalion, multi-modal operational maneuver, and battle command on the move. These new aircraft must be able to seamlessly interoperate with other forces, over greater distances, and be more lethal than ever before.

IOTE provides users the ability to employ equipment in realistic situations, and thereby judge the equipment's

ability to meet user requirements. To verify the Comanche's ability to meet user requirements, and thereby become the Army's first piece of the FCS, it must perform acceptably during IOTE. IOTE then, must be fashioned in such a way as to place the aircraft in situations that mimic the stringent demands of users during war fighting. To facilitate the process of crafting the IOTE, those involved use dendritics, which start by identifying the broad requirements necessary for the aircraft to be successful. From these broad statements, dendritics further break down into MOEs and MOPs, and finally data elements, which when answered in total, provide an objective means to gauge how well the aircraft performed.

III. MISSION SCENARIOS FOR IOTE

A. INTRODUCTION

The mission scenarios presented in this chapter are intended to serve as a basis for the Comanche IOTE test vignettes. These scenarios are based on the author's operational experience in several cavalry organizations, both divisional and regimental, as well as discussions with members of the test and evaluation community.

The Army's transformation to the Future Combat Systems provides significant challenges in defining adequate and accurate test events. IOTE for the Comanche presents a challenge in that not only must the aircraft meet its own performance objectives, but must also integrate with the FCS. The ability to test the aircraft's interoperability with the Future Combat System will prove difficult because all the systems that comprise the FCS will not be ready to test at the same time. In fact, the requirements for many of the systems that make up the FCS have not been finalized.

The scenarios presented here apply specifically to the Comanche's ability to meet its operational effectiveness

requirements. The following primary documents were used in developing the scenarios: the Operational Requirements Document (ORD), the Operational Mode Summary/Mission Profiles (OPMODSUM) for the RAH-66, the effectiveness dendritic presented in Chapter II, and the draft CONOPs.

As the ORD and OPMODSUM were written prior to defining FCS and the associated CONOPs, the mission scenarios presented here will add to or modify the concepts and requirements presented in earlier documents. Most of the requirements between the new and old missions remain the same. For example, the reconnaissance mission described in the OPMODSUM requires many of the same tasks as the reconnaissance mission described in the new CONOPs. Parallels can be drawn from every mission detailed in the OPMODSUM, and requirements from the ORD, to every mission listed as part of the future CONOPs. However, the requirements placed on the Comanche to fight as part of the envisioned FCS translates into additional tasks that do not appear in the OPMODSUM, and to a lesser extent, the ORD.

In addition to laying out mission scenarios that serve as a basis for IOTE, this chapter also identifies shortcomings in current documentation brought about by the Army's migration to the Future Combat Systems, and

ultimately the Objective Force. These shortcomings provide the basis for recommendations pertaining to developing the IOTE, presented in Chapter IV.

Each scenario includes a shaded operational effectiveness dendritic, depicting the level of opportunity to test and evaluate each MOP for the given scenario. For example, in a scenario with limited numbers of targets, the opportunity to examine the Comanche's ability to observe, acquire and prioritize targets will be limited. As a result, that set of MOPs covering target acquisition and prioritization will be lightly shaded. The dendritic's legend details the levels associated with the degree of shading. No shading indicates that the MOP is not tested or evaluated in that particular scenario.

Execution matrices are located in Appendices A-D, to provide more detail to each mission scenario. The execution matrices further depict the primary measures of performance available for test and evaluation in each scenario. MOPs are tied to events that occur in conducting the mission as it is laid out in the mission description. Using the mission description, the execution matrix sequentially lays out the actions taken by the unit, and identifies the MOPs that should be tested and evaluated for

each segment of the mission. An H-hour sequence is used to identify the time an event occurs in the mission. H-hour alone indicates the start of the mission. H-hour "+" an amount of time indicates the event occurs that many hours and/or minutes after the start of the mission.

Most of the measures of performance, to a certain extent, are present in every mission the Comanche conducts. As an example, MOP 1-1-3-2: Proportion of successful tactical voice communications within Comanche equipped units, by radio type and mode, occurs in every tactical mission. As a result, this particular MOP can be tested and evaluated every time two or more Comanches launch on a mission. Therefore, to narrow the intent for each scenario, the testing focuses identified are those requirements or MOPs unique to, or best presented in that given mission.

B. RECONNAISSANCE TO MOBILE STRIKE

1. Mission

Air Cavalry Troop (ACT) or Attack Helicopter Company (ATKHC), performs reconnaissance to locate, identify, and destroy (DID) Transport Erector Launchers (TELs) operating

within a 50x50 kilometer zone, 100 kilometers beyond FLOT, to deny enemies ability to interdict friendly staging operations. Mission takes place during the hours of darkness.

2. Test Focus

- Extended range, time on station, and payload capability.
- BLOS/NLOS communication.
- Off-board sensor employment.
- In-direct engagements.
- LO capabilities.
- ***Shipboard operations.

3. Mission Description.

Intelligence sources report TELs, accompanied by Air Defense Artillery (ADA), departing motorpools towards firing positions, which can range the coalition Point of Debarkation (POD). The division entering theater directs its assigned cavalry squadron the mission to conduct reconnaissance of a large zone in the enemy's rear area, projected to be the most likely firing points for the TELs.

The squadron commander assigns the mission to one of his air cavalry troops to locate and destroy the TELs. Besides the eight Comanche helicopters assigned, the troop will also have ATACMs in direct support. Two UAVs are also placed on order, under the troop commander's control to aid in the reconnaissance mission. Initially the UAVs will fly predesignated tracks as part of the ACT's reconnaissance plan, but can be retasked by the troop commander based upon mission needs during execution. JSTAR feeds will also be employed to aid in locating the TELs.

The ACT will task organize into Scout Weapons Teams (SWTs) as necessary to accomplish the mission, based upon approved Tactics, Techniques, and Procedures (TTPs), and aircraft availability. Each aircraft will be configured with auxiliary fuel to provide extended time on station, as there will be no refueling capabilities pushed forward. During the mission they are continually alert for enemy counter-air aircraft and remain ready to engage in air combat if they are threatened. Their weapons load is tailored for the mission and includes a mix of air-to-air missiles, antiarmor missiles, and cannon. [Ref. 10]

*This mission could also be modified to initiate/terminate from/to shipboard as a precursor to

friendly forces entering a port of debarkation (POD) to begin staging operations.

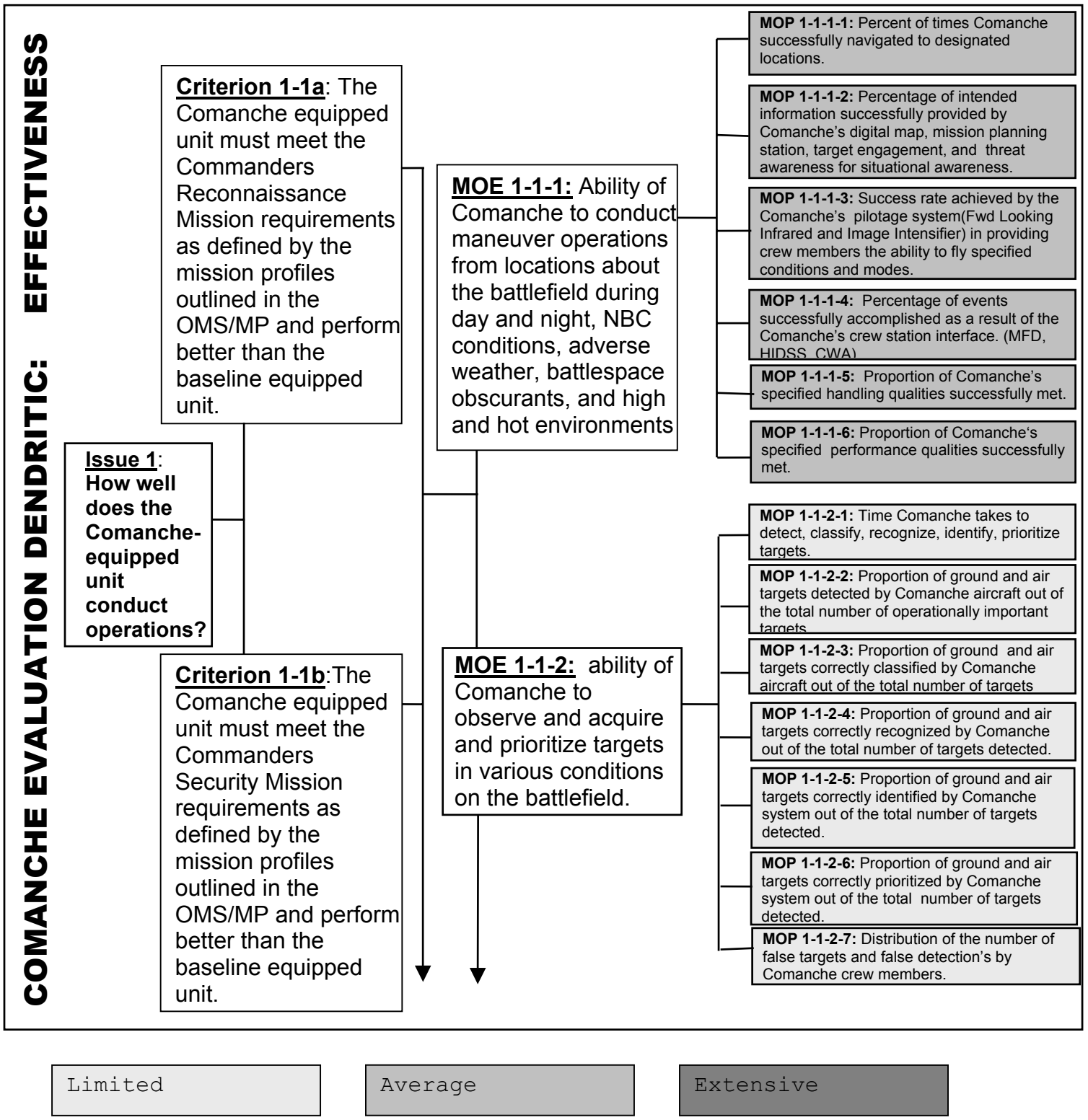

Figure 4. MOP Coverage for Reconnaissance to Mobile Strike

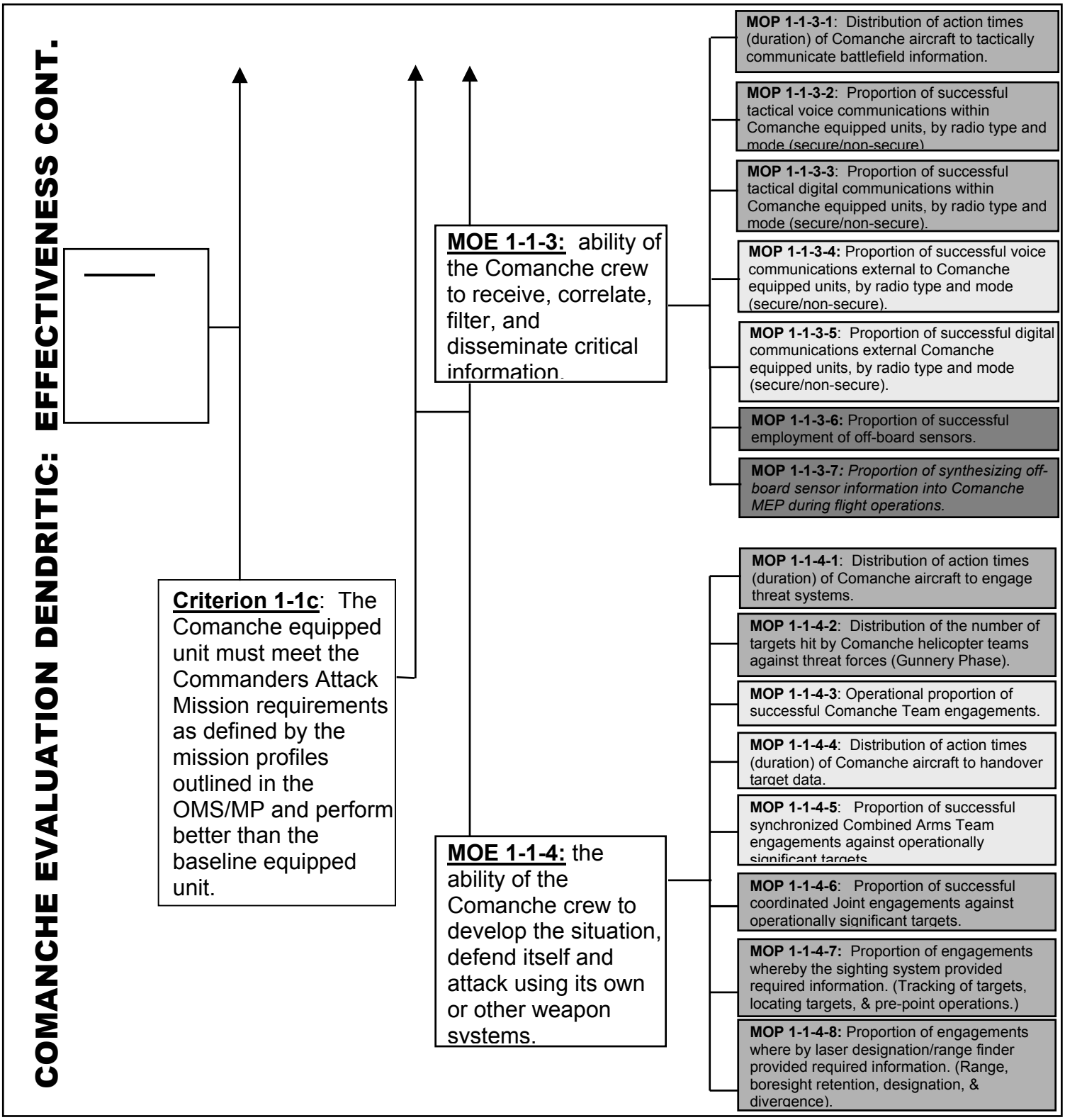

Figure 5. MOP Coverage for Reconnaissance to Mobile Strike

4. Mission Summary

This scenario, more than any other, stresses the Comanche's ability to meet its flying speed, auxiliary fuel, BLOS/NLOS communication, Low Observability (LO) and off-board sensor integration. Although almost all MOPs can be tested and evaluated, the limited number of targets will not stress the Comanche's ability to observe, acquire and prioritize targets in various battlefield conditions to the extent of other scenarios. Likewise, the Comanche's ability to communicate with external organizations is tested to a limited extent. This scenario does not examine air-ground interoperability.

C. CLOSE COMBAT WITH GROUND FORCES

1. Mission

ACT conducts movement to contact as part of a heavy divisional cavalry squadron, In Order To (IOT) gain contact and destroy enemy forces as part of an integrated air-ground team. The squadron must halt enemy forces at a distance outside of their artillery's ability to range the POD.

2. Test Focus

- Interoperability with ground forces.
- Provide extended target acquisition ranges.
- Detect, Identify, Affiliate and Engage Targets.
- Sharing COP with ground forces.
- Employing indirect fires from joint assets.

3. Mission Description

As friendly forces continue to build combat power, the first division on the ground begins to push out the perimeter to gain reaction time and maneuver space. Enemy forces are pushing forward to destroy friendly units, and deny their use of port facilities to continue the buildup. As a result, the friendly commander assigns the divisional cavalry squadron the mission to conduct a movement to contact to halt the approaching enemy forces as far from the port of entry as possible.

The cavalry squadron executes the line of departure (LD) with one ACT, and two Ground Cavalry Troops (GCT) forward. The ACT bounds forward, staying one (PL) ahead of the GCTs, providing early warning of enemy forces. This allows the GCTs to rapidly maneuver forward in traveling

overwatch formation. JSTARS and UAVs also provide the squadron intelligence on the enemy's movement, enhancing situational awareness and lessening the likelihood of unexpected contact.

As the two forces converge, the ACT destroys the enemy's reconnaissance assets and provides the GCTs intelligence as they deploy to begin engaging. As the GCT begins direct fire engagements, the ACT takes up overwatch positions on the squadron's flanks to provide security and shift its reconnaissance focus deeper for follow on forces. The ACT engages high priority targets with direct fires, and utilizes indirect fires to harass incoming enemy forces to disrupt and fragment their formations. This disruption precludes the enemy massing on the GCTs, allowing them to engage and destroy targets piecemeal.

The ACT will configure the SWTs with primarily hellfire and 20mm ordnance, but also arm selected aircraft with stingers to provide protection against enemy aircraft. Once enemy contact is made, the ACT will also conduct JAAT operations to destroy enemy forces.

This scenario ends with the enemy going to ground, establishing a hasty defense behind the positions where the cavalry squadron destroyed his leading battalions. The

division’s Brigade Combat Teams (BCTs) followed the squadron’s advance and have also set up defensive positions, keeping friendly forces beyond enemy artillery range at the POD.

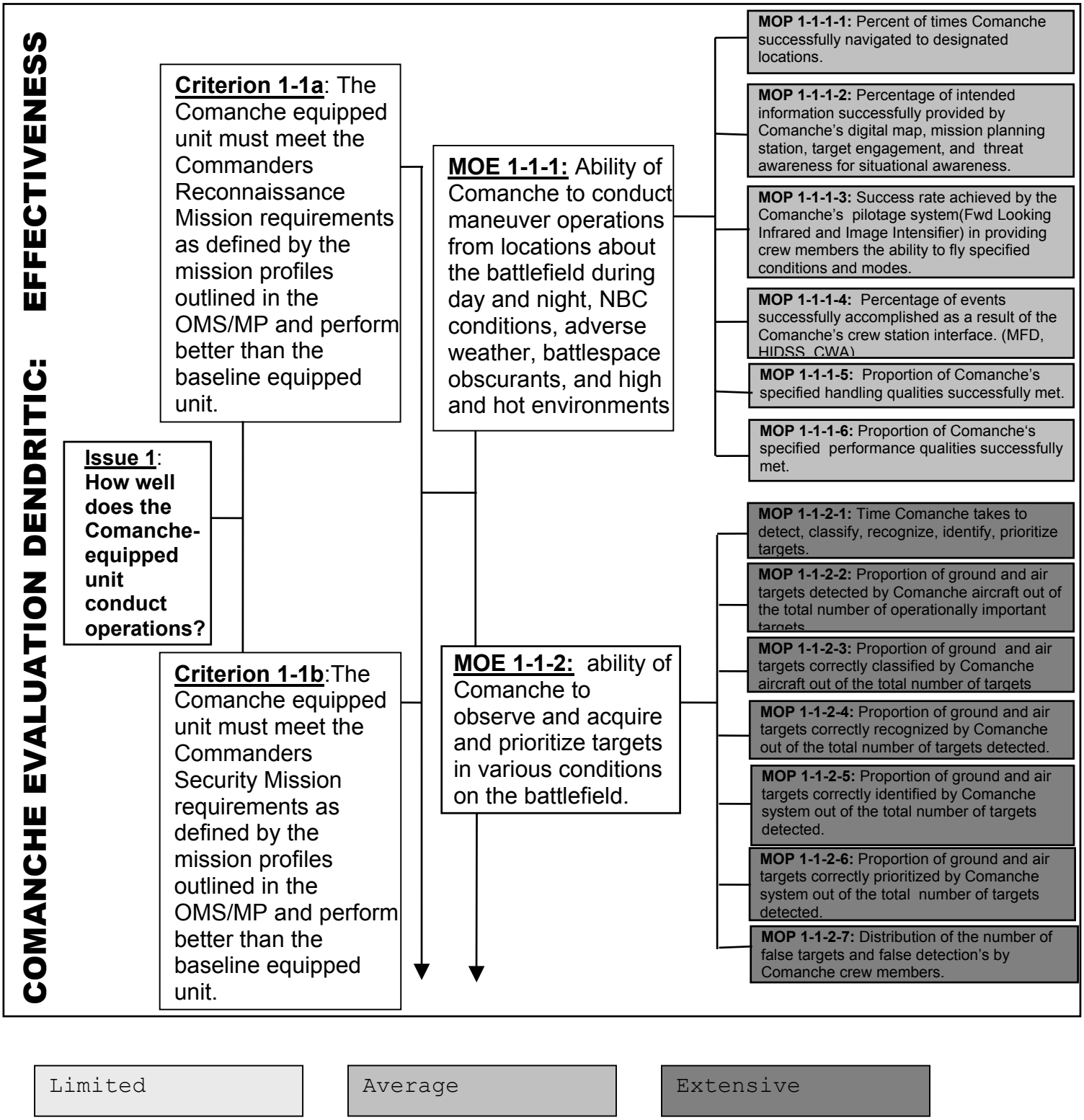

Figure 6. MOP Coverage for Close Combat with Ground Forces

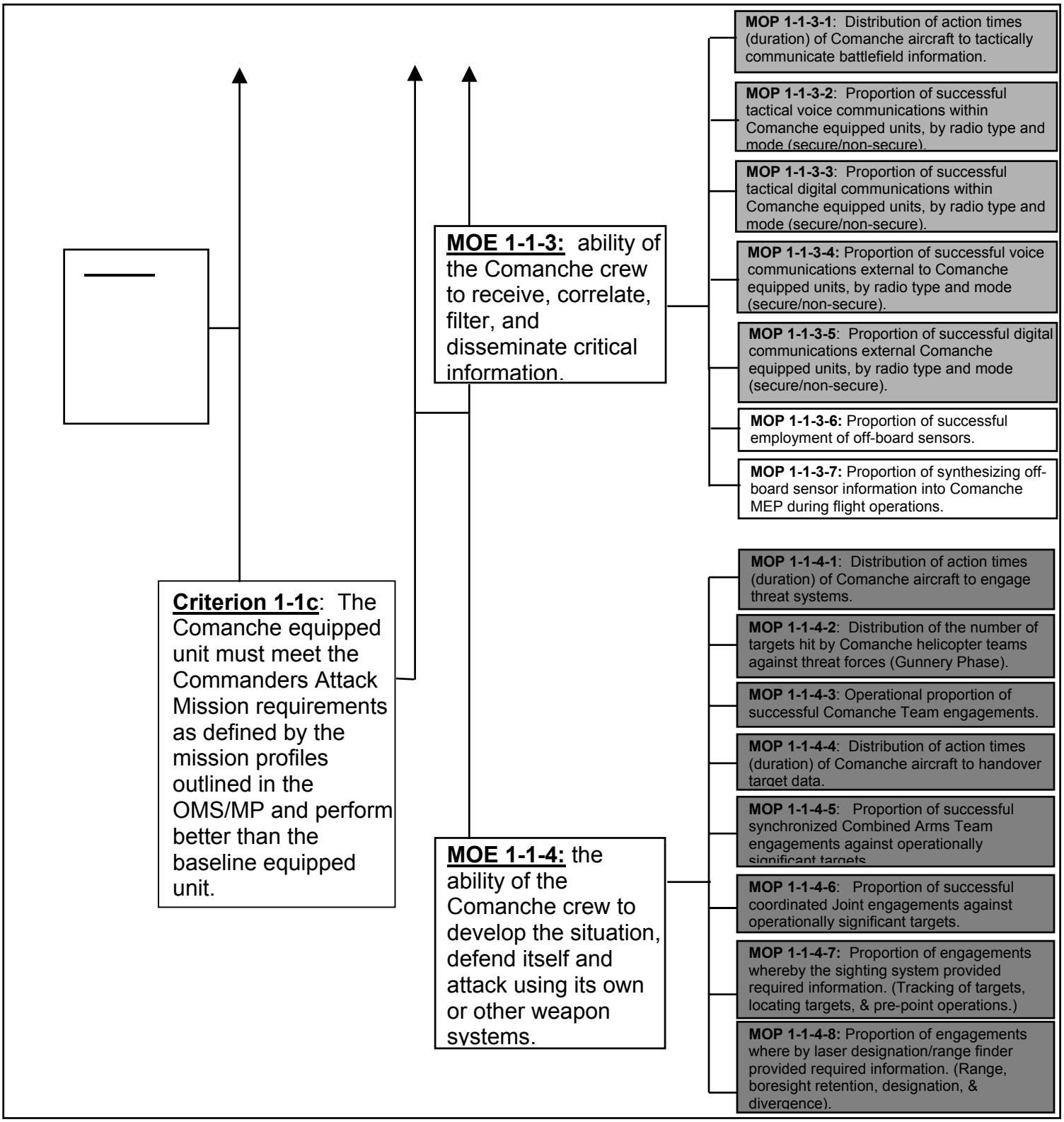

Figure 7. MOP Coverage for Close Combat with Ground Forces cont.

4. Mission Summary

This scenario focuses on air-ground interoperability. Maintaining situational awareness during rapid joint air-ground maneuver, especially with heavy enemy contact, is extremely difficult. The Comanche MEP must assimilate and share necessary information between all team members, helping to build an accurate common operating picture. Accurate information sharing becomes more critical as SWTs rotate into and out of the FARP. Total situational awareness must be maintained to prevent loss of aircraft, or loss of enemy contact. Comanche sensors must detect, identify and destroy enemy forces at extended ranges.

D. MOBILE STRIKE

1. Mission

Light Attack Company conducts a deep attack during the hours of darkness to destroy an enemy armor battalion marshalling to go on the attack. The enemy's objective is to take the port facility to deny friendly forces the ability to continue to build combat power.

2. Test Focus

- Extended range, time on station, and payload capability.
- LO capability.
- BLOS/NLOS communication.
- Off-board sensor employment.
- Direct fire engagements.
- In-direct fire engagements.

3. Mission Description

After the enemy's initial attack failed to take the port facility, he has established defensive positions and is gathering his own combat power to conduct a larger attack. His goal is to overmatch friendly combat power on the ground, seize the port facility, and disallow our ability to continue to build forces.

The center of gravity for the enemy attacking force is an armor brigade marshalling behind his defensive positions. There is currently one battalion in place, with the remainder of the brigade expected to form within the

next 36 hours. The battalion is protected from air attack by an air defense artillery battery.

To destroy the enemy's center of gravity, and preempt his attack, the friendly division assigns one of its Light Attack Companies a deep attack mission against the building armor forces. The attack is planned to occur during the hours of darkness, with the company cycling through a Forward Arming and Refueling Point (FARP) in order to engage the targets twice. The company will fly a planned route into battle positions, from which they will engage and destroy as many enemy vehicles as possible. After the company expends all their ordnance, the unit will egress the area to a FARP, rearm and refuel, then fly to other assigned battle positions to continue the attack. After the company expends all ordnance the second time, or has no further targets to engage, they return to base to prepare for future operations.

To support the attack, the division again employs UAVs and JSTARS to maintain contact with enemy forces. Limited ATACMs will also be used to provide Suppression of Enemy Air Defense (SEAD), both for the ingress and egress of the attack company.

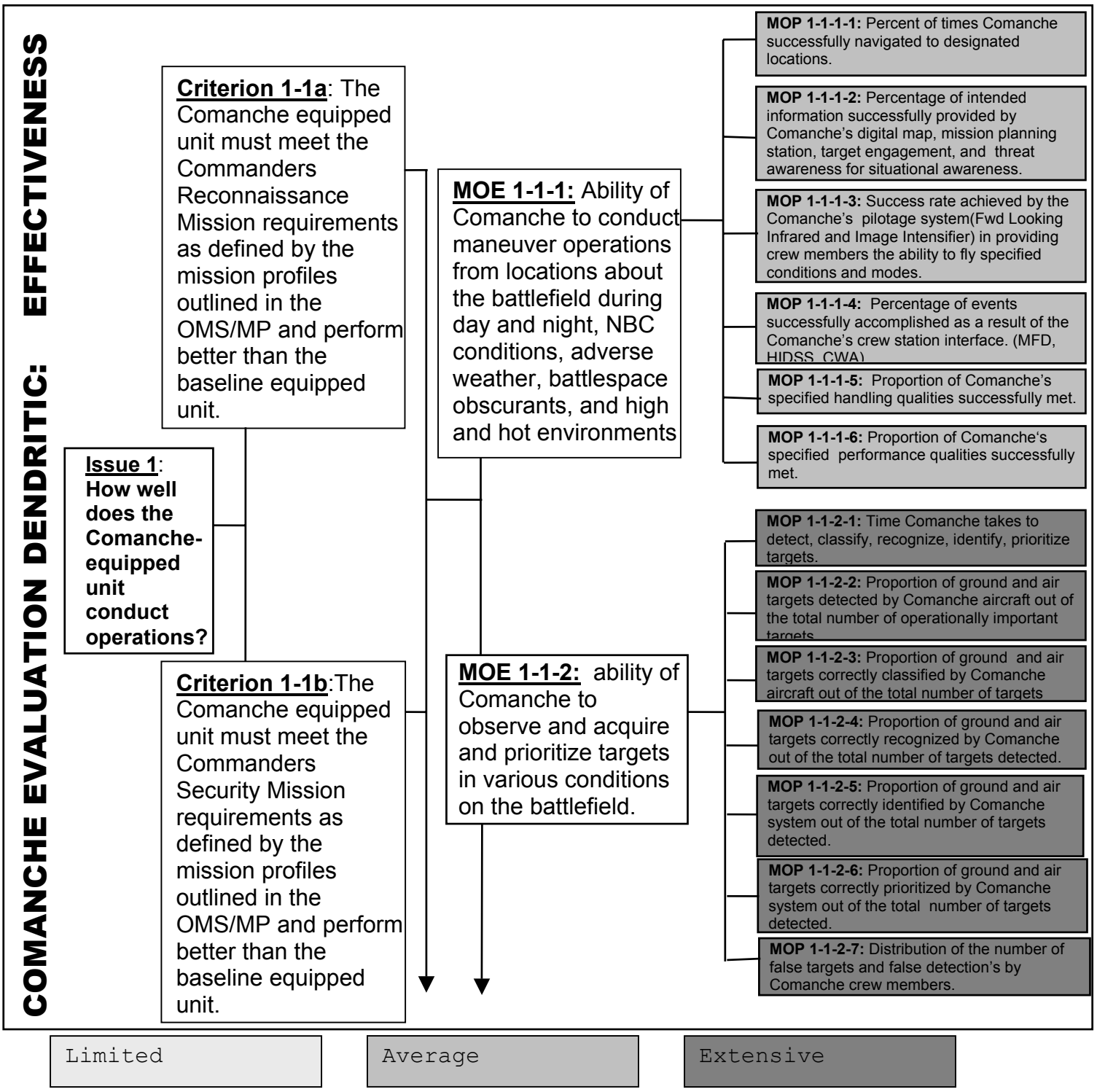

Figure 8. MOP Coverage for Mobile Strike

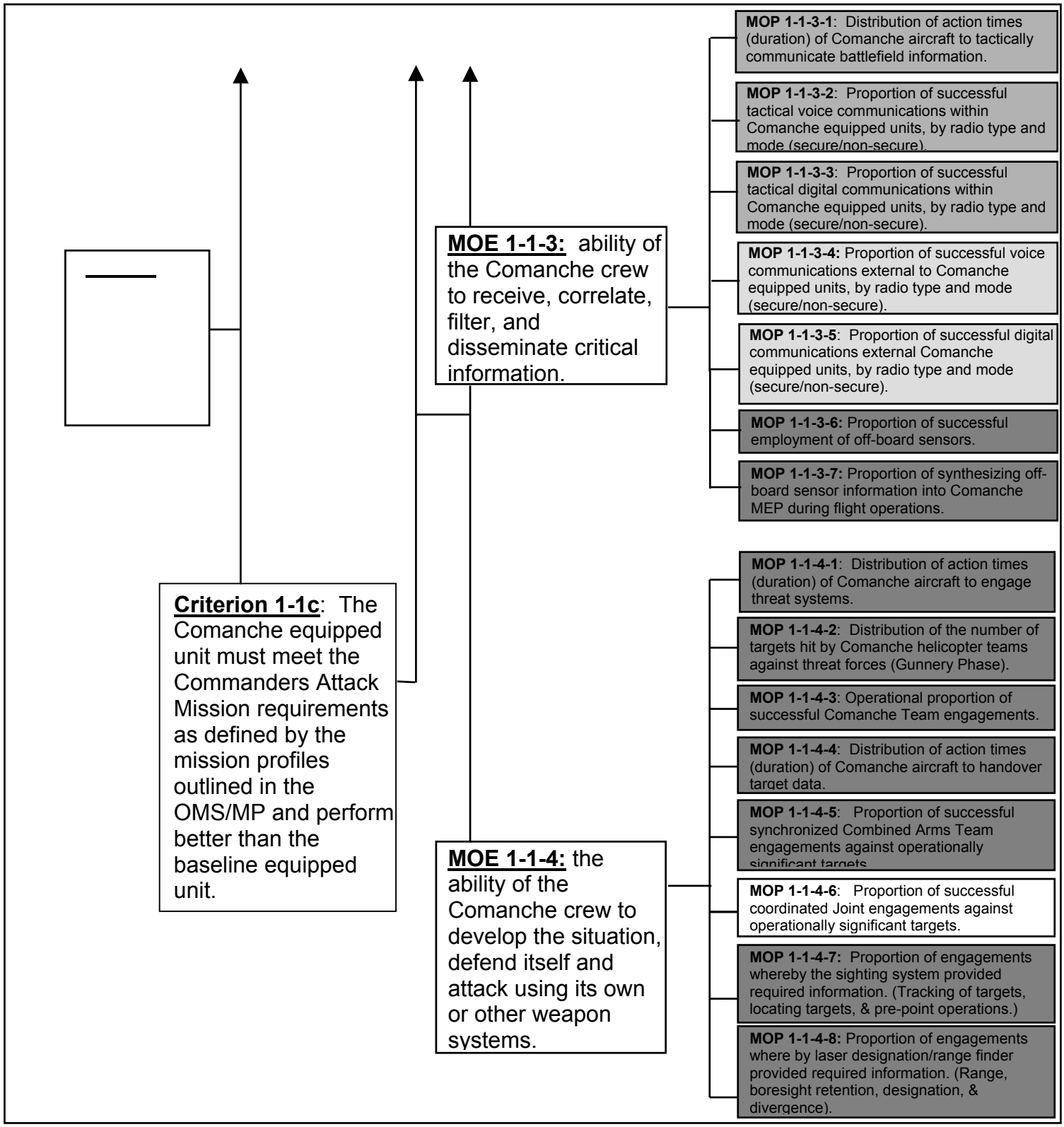

Figure 9. MOP Coverage for Mobile Strike cont.

4. Mission Summary

This scenario focuses on the Comanche's lethality in a target rich environment. Utilizing its advanced systems, the aircraft should be able to quickly maneuver to a firing position, scan for targets, prioritize, and then assign targets to the entire team of Comanches. Engagements should be quick and deadly, with all aircraft firing near simultaneously. This scenario also tests the aircrafts ability to not only discern different types of vehicles through heavy obscurants, but also its ability to verify BDA.

E. MULTI-MODAL OPERATIONAL MANEUVER

1. Mission

The division's cavalry squadron, as part of the division's attack, assumes blocking positions beyond the division's objective, to prevent enemy reinforcements from engaging attacking forces.

2. Test Focus

- Sharing COP with all members of the air ground team.
- Capability to retask sensors.
- Provide extended target acquisition ranges.
- Detect, Identify, Affiliate and Engage Targets.
- Synchronize joint and organic fires.

3. Mission Description

After losing the majority of an armor battalion to the deep attack, the enemy postpones his attack, and continues to reposition forces in an effort to build sufficient combat power to attack. Friendly forces also continue to build, with all the division's BCTs on the ground, and its logistics support offloading in the POD.

The division conducts an attack to seize the initiative, expand the division's footprint, and continue to disrupt the expected enemy attack. The division's objective is key terrain, twenty kilometers behind the FLOT. The attack initiates in the hours of darkness with a Comanche equipped attack company moving forward to engage and destroy the enemy's Regimental Artillery Group (RAG),

using both joint and organic fires. Shortly thereafter, one of the BCTs moves forward to breach the enemy's defenses. First through the breach will be a second BCT, which will maneuver to engage the enemy's reserve forces, allowing the division's cavalry squadron to maneuver unhindered through the breach, and continue to positions beyond the objective, blocking expected reinforcements. The squadron will maneuver with an air cavalry platoon forward, conducting reconnaissance, allowing the GCTs to race to their blocking positions. The second air cavalry platoon launches as needed to relieve the platoon forward.

Once the squadron is established in its blocking positions, the ACT will screen forward, providing early warning. Based upon the situation, the squadron will conduct a rearward passage of lines, through the BCTs consolidated on the objective, or conduct a relief in place. As with all the other scenarios, the ACT will plug into all the joint assets providing battlefield information, such as UAVs, JSTARS and other Comanches.

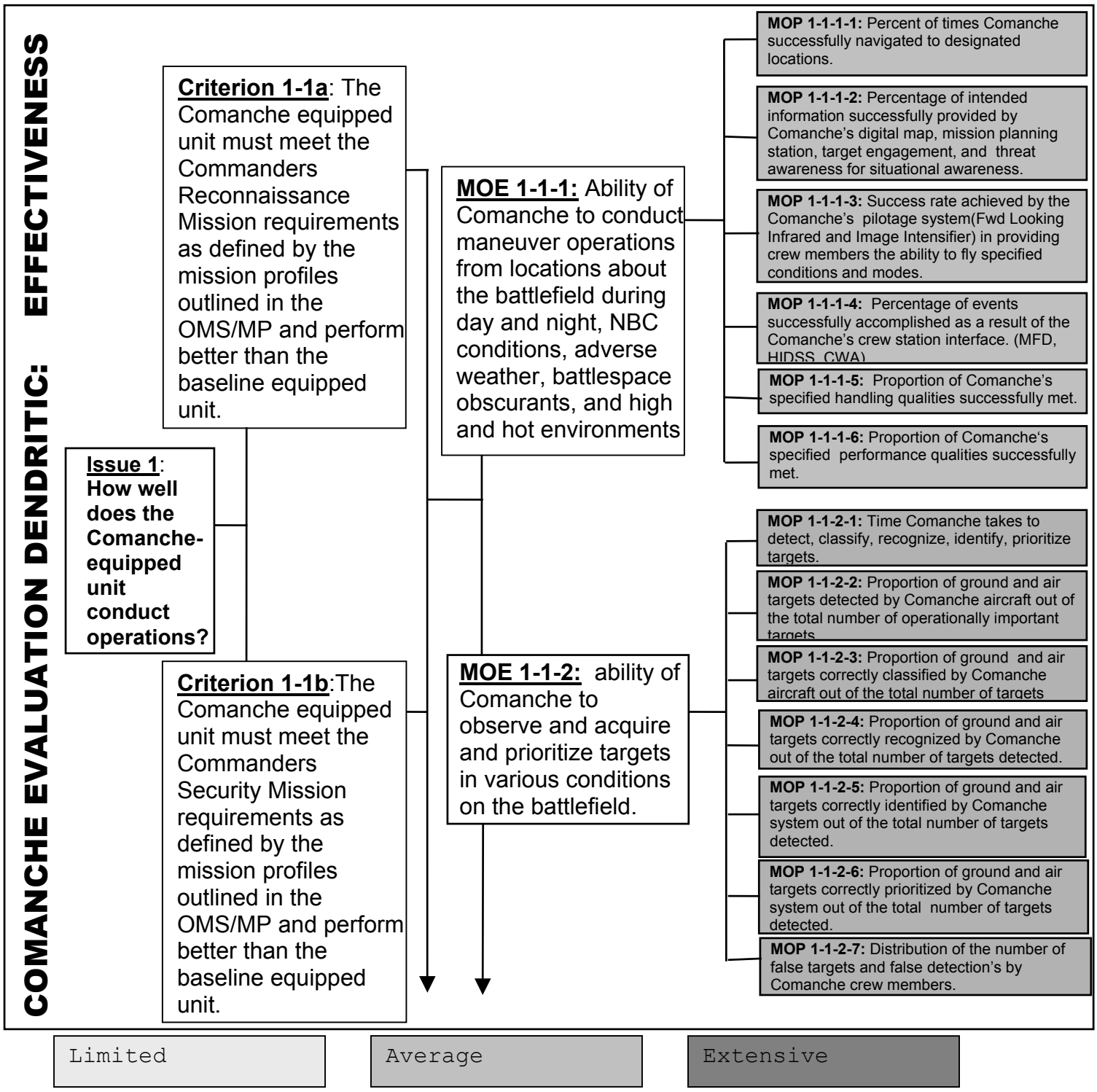

Figure 10. MOP Coverage for Multi-Modal Operational Maneuver

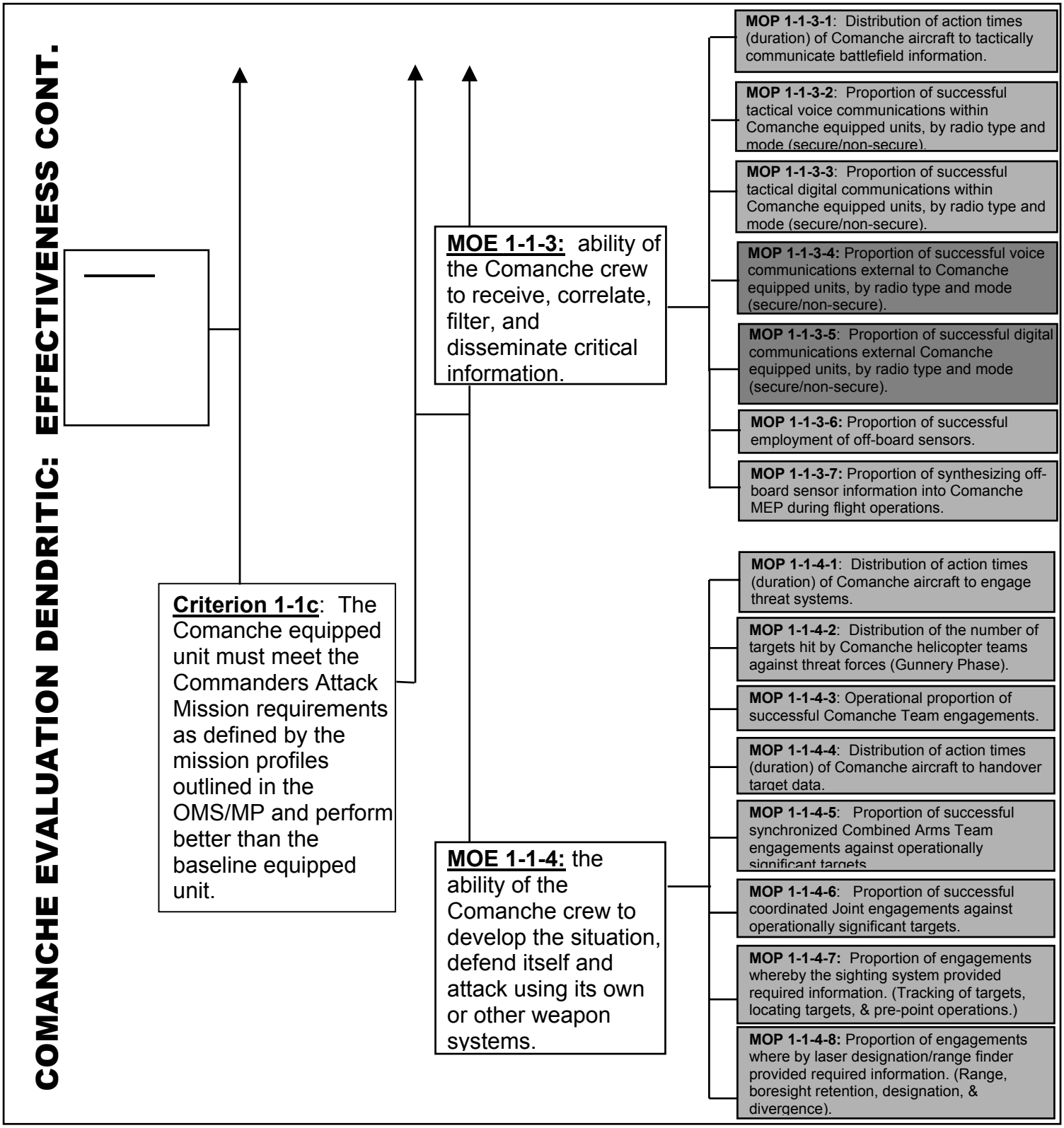

Figure 11. MOP Coverage for Multi-Modal Operational Maneuver cont.

4. Mission Summary

This scenario tests the Comanche's ability to work with several different maneuver units operating in close proximity on the battlefield. The aircraft must be able to differentiate between friendly organizational, non-organizational and enemy vehicles. The common operating picture must be accurate enough to allow the squadron's aircraft to be given a new mission, with another ground element, without having to spend an inordinate amount of time on the radio or conducting a face-to-face meeting to gain situational awareness. Further, as teams rotate to and from the FARP, the Comanche's systems must develop and sustain a common operating picture that allows quick assumption of the duties left by the departing team.

F. SUMMARY

The author's scenarios presented in this chapter, reconnaissance to mobile strike, close combat with ground forces, mobile strike, and multi-modal operational maneuver serve as a basis for the Comanche IOTE. These missions, as part of the aviation CONOPs, examine the Comanche's ability

to meet the Army's requirements of its future aircraft. Each scenario, to varying degrees, address almost all of the MOPs detailed in the operational effectiveness dendritic. However, each scenario is uniquely fashioned to focus on specific requirements, testing to what degree the Comanche is able to perform those requirements that serve as the focus of the particular scenario. Chapter IV identifies each scenario's focal requirements, and describes how the scenario tests those requirements.

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IV. ANALYSIS

A. INTRODUCTION

IOTE is a critical step in the acquisition process. It is the first time users get to employ the equipment, ensuring it will meet their needs in the conditions that they operate. Bench tests and successes in the rigidly controlled environment of the lab must be proven in the chaotic realm of the war fighter. To effectively prove the tested equipment meets the ultimate requirements set forth by the users, the IOTE must be fashioned as realistically as possible to mimic the rigorous demands of battle.

The purpose of IOTE is spelled out in several references. However, the method to conduct the actual event is not so neatly delineated. While the general principles for IOTE are the same for every test, each test is uniquely different from the next. Many factors must be considered when developing the IOTE, much more than the basic who, what, why, when and where. Chief among considerations when developing the IOTE is funding, especially because the event is extremely expensive. The money available to conduct the test and evaluation

determines what, and to what extent, different functions or capabilities of the equipment in question will be tested. With a funding limitation, test developers must determine the most critical functions or capabilities to test. Therefore, the scenarios presented in Chapter III focus on the areas the researcher deems most important, in terms of mission capabilities that the Comanche must possess. Increased capabilities that the Comanche must possess are extended range and station times, superior sensor suites, increased maneuverability and speed, and increased survivability. Just as critical, the Comanche must possess integrated communications system to share the information it collects across the entire spectrum of joint operators. Integral to sharing information, the Comanche's systems must aid the crew in synthesizing the common operating picture required to successfully operate on the fluid and dynamic battlefield of the future.

This chapter will first identify those areas in which the scenarios overlap, drawing out those MOPs and capabilities that are present to test in every scenario. Following this, the scenarios will be analyzed individually to elicit the specific capabilities the scenario was crafted to showcase. The final analysis of the scenarios

identifies means to conduct the Comanche IOTE if funding limits the number of missions able to be run. The chapter concludes by identifying items that need to be addressed in Follow On Test and Evaluation (FOTE).

B. COMMON TEST OBJECTIVES AND REQUIREMENTS

Many of the scenarios presented in Chapter III share a number of common testing foci, in terms of capabilities that the Comanche must perform. The scenarios are not redundant however. The scenarios test the aircraft's capabilities to different degrees. For instance, the first scenario tests BLOS/NLOS communications at a greater distance than the third scenario. Both scenarios require vast improvements in communications existent in helicopters currently fielded, but the first scenario requires it 100 kilometers further than scenario three. These scenarios then will test the degree to which BLOS/NLOS communications work at varying distances. Communications tested include both voice and digital, between several different systems.

In reviewing the shaded dendritics in Chapter III, it quickly becomes apparent that almost all the MOPs associated with operational effectiveness are present in

all the scenarios to varying degrees. Similarly to the testing focus described in the previous paragraph, the scenarios are designed to stress those MOPs most prevalent in the given scenario. Testers and evaluators can choose to gather data on all possible MOPs in every scenario, or gather data when the MOPs are most stressed by a scenario. Section C details the critical capabilities that each scenario was designed specifically to evaluate, though many of these MOPs and capabilities exist in other scenarios as well.

C. UNIQUE TEST OBJECTIVES AND REQUIREMENTS

1. Reconnaissance to Mobile Strike

This scenario requires the Comanche to prove its ability to travel extended distances undetected, maintain ample station time to conduct thorough reconnaissance, and utilize its BLOS/NLOS communication capability to relay information over extended distances. This scenario also integrates off-board sensors to a greater extent than any other mission scenario.

Of the four scenarios, this is the only one that requires the Comanche to employ its auxiliary fuel requirement. The aircraft must be reconfigurable to provide extra station time without significant degradation in its LO capability. Iddeally, adding the extra fuel will not make the aircraft more susceptible to detection by radar or IR systems. Traveling deep into enemy territory, through numerous Air Defense system's acquisition envelopes, and then conducting reconnaissance of a large area, provides testers and evaluators the opportunity to examine both of these capabilities.

Also crucial to success in this scenario is the aircraft's ability to utilize off-board sensors such as JSTARS and UAVs. To adequately conduct reconnaissance of a 50X50 kilometer zone, with the time constraint of one fuel load, requires the full integration of all sensors available. If aircraft casualties occur during the conduct of this mission, off-board sensors become even more important.

The following critical capabilities are most stressed in this scenario, compared to the other four:

- Auxiliary fuel.
- Off-board sensor employment/integration.

- BLOS/NLOS communications.

2. Close Combat with Ground Forces

The focus for this scenario is to test the Comanche's ability to interoperate with and enhance the air-ground team. Rotary wing aircraft have long been valuable assets in conducting air-ground operations, including reconnaissance, attack, and command and control. The Comanche must prove to conduct these missions substantially better than aircraft currently in use. The primary enhancements Comanche potentially makes to the air-ground team is its superior ability to acquire information, share that information throughout the team, and destroy threats more efficiently.

The Comanche must acquire targets at greater distances, and be able to share that information more quickly, over greater distances than current practice. More simply, provide ground forces complete threat information, earlier. This allows the ground maneuver commander more time to evaluate the reported information, formulate a plan, and put the plan into action. All of

this translates into better decisions and a greater chance for success.

Also important as an air-ground team member is the ability to destroy threats. To destroy threats, systems must first be able to acquire them. As discussed already in the reconnaissance scenario, the Comanche's greater ability to detect threats improves its ability to be more lethal. Couple this with enhanced weaponry, and the Comanche will be more lethal than any aircraft fielded to date.

BLOS/NLOS communication plays a crucial role in both of these requirements. The ability to pass information over greater distances equates to more time on the battlefield to make decisions. The earlier threats are detected and reported, the earlier the force commander begins his planning and execution process. As well, the ability to talk over greater distances makes the Comanche more lethal. Previously, aircraft were limited in their ability to engage targets with indirect fires because of the lack of range in the aircraft's communications systems. With BLOS/NLOS communications, Comanche equipped units can call for and adjust fires up to the range limitation of the firing system, not communication system.

The following critical capability is most stressed in this scenario:

- Air-ground interoperability

3. Mobile Strike

This scenario focuses on the Comanche's lethality, primarily using direct fire. By isolating a company of Comanches against a target set, testers and evaluators can accurately gauge the success of the aircraft in acquiring, prioritizing and destroying targets. Prioritization is key, as the aircraft's weapons system has been designed to prioritize targets, taking people initially out of the loop. The operator can override all systems, but this obviously defeats the benefit of having a computer accomplish prioritization more quickly. Another benefit of the computer is the elimination of human error.

The lethality focus of this scenario overlaps with live fire testing. However, the operational context of the scenario extends beyond where live fire testing ends. The live fire test (LFT) does not focus on the operational employment of the aircraft. Rather, the LFT focuses more on the aircraft hitting and destroying its intended target.

Although the LFT can be made to mimic an operational engagement, firing ranges by their very nature make operational employment using correct TTP difficult. Safety requirements of the range many times prohibit realistic employment of aircraft weapons systems. However, using the aircraft's training devices, in concert with test instrumentation, all the tasks associated with actually shooting live ordnance can be accurately accomplished in a testing or training scenario. Through the use of instrumented targetry and aircraft, testers and evaluators (T&E) can realistically determine if the firing aircraft hit what it shot at. These results, coupled with the LFT results, allow the T&E community to extrapolate the lethal effectiveness of the aircraft in a true operational setting.

This scenario also overlaps with scenario one to a limited extent. Both of the scenarios require the Comanche to maneuver deep beyond the FLOT, communicate via BLOS/NLOS means, and integrate off-board sensors. The difference lies in the degrees these three capabilities are exercised. It has already been established that scenario one was specifically designed to stress these three capabilities. Therefore, the major difference for this scenario is the

plethora of targets that the Comanche must destroy as part of a deep mobile strike.

The company of Comanches will first be required to maneuver quickly, and preferably undetected to Attack By Fire (ABF) positions from which to engage the enemy vehicles. Where the first scenario required auxiliary fuel to accomplish the mission, this scenario requires additional ordnance. Each aircraft will be armed with 16 hellfires and 500 rounds of 20mm, as described in the Light Division, Close Operation – Southwest Asia mission profile of the OPMODSUM [Ref. 10]. (If the test aircraft do not have the capability to mount 16 hellfires, the test will be conducted with the full complement of hellfires the test aircraft can employ.)

Once the aircraft have reached the ABFs, the designated aircraft(s) scan for targets. After acquiring the targets, the aircraft must correctly identify and prioritize them. The aircraft must then assign its sister aircraft targets. Once all parameters are verified, the company engages targets until expending all ordnance, or destroying all detected targets. Once either of these two parameters has been met, the company egresses to a

designated FARP to refuel and rearm, in preparation to conduct another rotation to the target area.

Enroute to the FARP, the company must accurately accumulate Battle Damage Assessment (BDA) and report that to headquarters. Likewise, UAVs will be used to assess BDA, and also provide information to the company, providing situational awareness as they prepare to again enter zone to conduct another attack. The second attack will follow the same outline as the first attack.

The following critical capability is most stressed in this scenario:

- Target acquisition, prioritization, and engagements.

4. Multi-Modal Operational Maneuver

This scenario tests the ability of the Comanche to synthesize all the information received from the myriad of systems throughout the battlefield, into an accurate and total common operating picture. Further, this COP must be easily intelligible to the crew. The level of situational awareness required by the cavalry, especially its air troops, is unmatched. It is not uncommon for the squadron to switch controlling headquarters from the division to one

of its BCTs in the midst of battle, sometimes changing missions at the same time. This shift on the fly requires complete situational awareness, as to friendly and enemy locations, and common graphic control measures from which to operate.

As part of the Comanche operating systems, common graphics and fragmentary orders (FRAGO) can be disseminated to the entire troop in seconds. These systems will also illustrate the locations of friendly and enemy units. With this information, an air troop can quickly re-orient and begin execution. If the Comanche performs as expected, what used to take either long and detailed radio communications, or face-to-face meetings, can now be accomplished with fewer errors, very quickly.

Requiring the air troop to maneuver, staying tied into other units outside of the squadron tests the Comanches ability to build and display an intelligible COP. Issuing the troop a FRAGO, requiring it to accomplish a new mission under the control of another headquarters, further tests this capability.

This scenario presents a unique challenge. It is unrealistic and cost prohibitive to include two BCTs in IOTE. Simulation will be required to portray the BCTs to

the applicable Comanche systems, providing the crews accurate information to properly conduct the scenario.

The following critical capability is most stressed in this scenario:

- Building and sharing a common operating picture.

D. METHODS TO MAXIMIZE LIMITED RESOURCES

1. Combined Scenarios

Analysis shows that the scenarios test many of the same MOPs and capabilities, albeit to different degrees. This fact then leads to opportunities to garner effectiveness and efficiency tradeoffs, especially in the event insufficient resources are allocated for all four scenarios. A combination of scenarios can be used to provide evaluation data. This combination will not provide the breadth of data afforded by all four scenarios, but will provide sufficient data on which to base an IOTE decision. The lack of data will lead to lower confidence levels on which to base quantitative decisions, but not the ability of testers, evaluators and users to determine how well the aircraft accomplished its mission. Therefore, to

be able to determine if the Comanche performed to the required standard, the combined scenarios must be fashioned to put the aircraft in as many, if not all, the situations which the aircraft must accomplish when fielded.

The optimal solution is to combine the scenarios in such a way as to maximize the information gathered, while minimizing costs and schedule requirements. To accomplish this, test formulators must evaluate the marginal gains of an event compared to its cost. To illustrate, two of the scenarios require BLOS/NLOS communications. One scenario requires this capability beyond 150 kilometers, the other beyond 100 kilometers. Based upon knowledge of communications systems, and results of Developmental Tests (DT), testers and evaluators can extrapolate with a high degree of confidence that the communications systems will work at all ranges up to the range exhibited in the 150 kilometers scenario.

When combining scenarios, all the critical capabilities must be tested and evaluated. The scenarios that should be combined are those that share the most MOPs/capabilities tested. As the scenarios have been laid out by the author in Chapter III, the four can be combined

into two, while still testing and evaluating all the critical capabilities the Comanche must possess.

The first amalgamation would combine scenarios one and three, with some modifications. The new scenario would be modified into a deep mobile strike, which would require the Comanche unit to fly 200 kilometers to reach their ABFs. The targets would remain the armor battalion from the original scenario three mobile strike. This modification would still require the Comanche to demonstrate its auxiliary fuel, BLOS/NLOS communication, and off-board sensor integration from the first scenario. Including the target set from scenario three enables testers and evaluators to examine the critical capability from that scenario, which was to examine the Comanches ability to acquire, prioritize and destroy targets.

This leaves scenarios two and four to be combined. This combination would also require some modifications to the scenarios. The ACT conducts the close combat with ground forces as described in scenario two, with the division's other units being simulated and fed into the Comanche's systems. Once the squadron's GCTs have destroyed/halted the enemy, the ACTs would receive a FRAGO to conduct the attack described in scenario four. This

combined scenario tests the critical capabilities of interoperability with ground forces, and building/sharing the COP.

The disadvantage of combining scenarios is less data gathered to evaluate. Even if the scenarios are combined without losing any operational reality, the aircraft will still fly less, and generate less test data. Whereas the key operational efffectiveness MOPs may be tested sufficiently in fewer hours, the sustainability MOPs most likely will not be. Many of the sustainability MOPs require adequate flight hours to evaluate the durability and integrity of aircraft components, ensuring the aircraft meets its Operational Readiness requirements.

Regardless of which requirements are affected more by less flying and thereby less testing, the ability to accurately examine almost all requirements will be impacted adversely. This becomes more apparent when you consider that the ideal situation calls for running scenarios redundantly, in different operating conditions, to test the complete spectrum of conditions in which the Comanche will be expected to perform. If limited resources force testers to combine scenarios, logic dictates that the ability to run redundant tests will also be limited. This limited

amount of test data reflects directly on the confidence levels of the outcomes of IOTE. These outcomes influence the decision-makers' ultimate decision of accepting or rejecting the aircraft. The small sample size of eight aircraft, coupled with limited flying during IOTE, could provide skewed data to the decision-makers.

2. Test Area Layout

To ensure the preponderance of funds allocated to IOTE actually test and evaluate the Comanche, the overhead of conducting IOTE must be kept to a minimum. To accomplish this, all the ancillary costs associated with testing, measuring and capturing data need to be kept to a minimum. With reducing costs in mind, the test should be critically planned to achieve that end.

When physically setting up a test, testers must emplace test equipment, survey its location, and validate its ability to provide the desired information. All of this requires time and money. Common sense dictates that these costs should be incurred only once if possible. Having to move the test equipment for each scenario significantly increases cost. Not only does it increase

costs associated with the test equipment itself, but equates also to extra days on the range to accommodate the labor associated with moving/revalidating the test equipment. With this in mind, the cost of IOTE can be reduced if the test equipment is laid out in such a fashion that the requirements of all the scenarios can be met.

Figure 12 depicts a test layout that accomplishes this. Around the periphery of the figure are ADA systems depicted by diamonds. In the center of the figure are company sets of armor targets, interspersed with miscellaneous other ADA, artillery, and command and control vehicles.

The missions associated with two of the scenarios are depicted on the figure to illustrate the objective of this test layout. The long thin arrows show the flight route of a deep attack into ABFs used to engage the battalion set of armor targets. The thick arrow representing an axis of attack, illustrates how the close combat with ground forces scenario can be run on the same test layout.

This layout provides the ability to accomplish all the scenarios detailed in Chapter III. Flying different routes around the periphery, turning on different sets of ADA systems, allows testers and evaluators to examine the

Comanches LO capabilities in the scenarios without allowing operators to "learn" the course. At the same time the aircraft's LO capabilities are examined, the extended range requirement is too. The threat layout also accomplishes all the requirements of the scenarios if the test unit attacks, conducts reconnaissance, or screens from different directions/orientations. Mixing target sets aids in presenting a different aspect to the testing unit as well. Based on the particular mission, testers can fashion the instructions given to the test unit to gain the information required by each scenario.

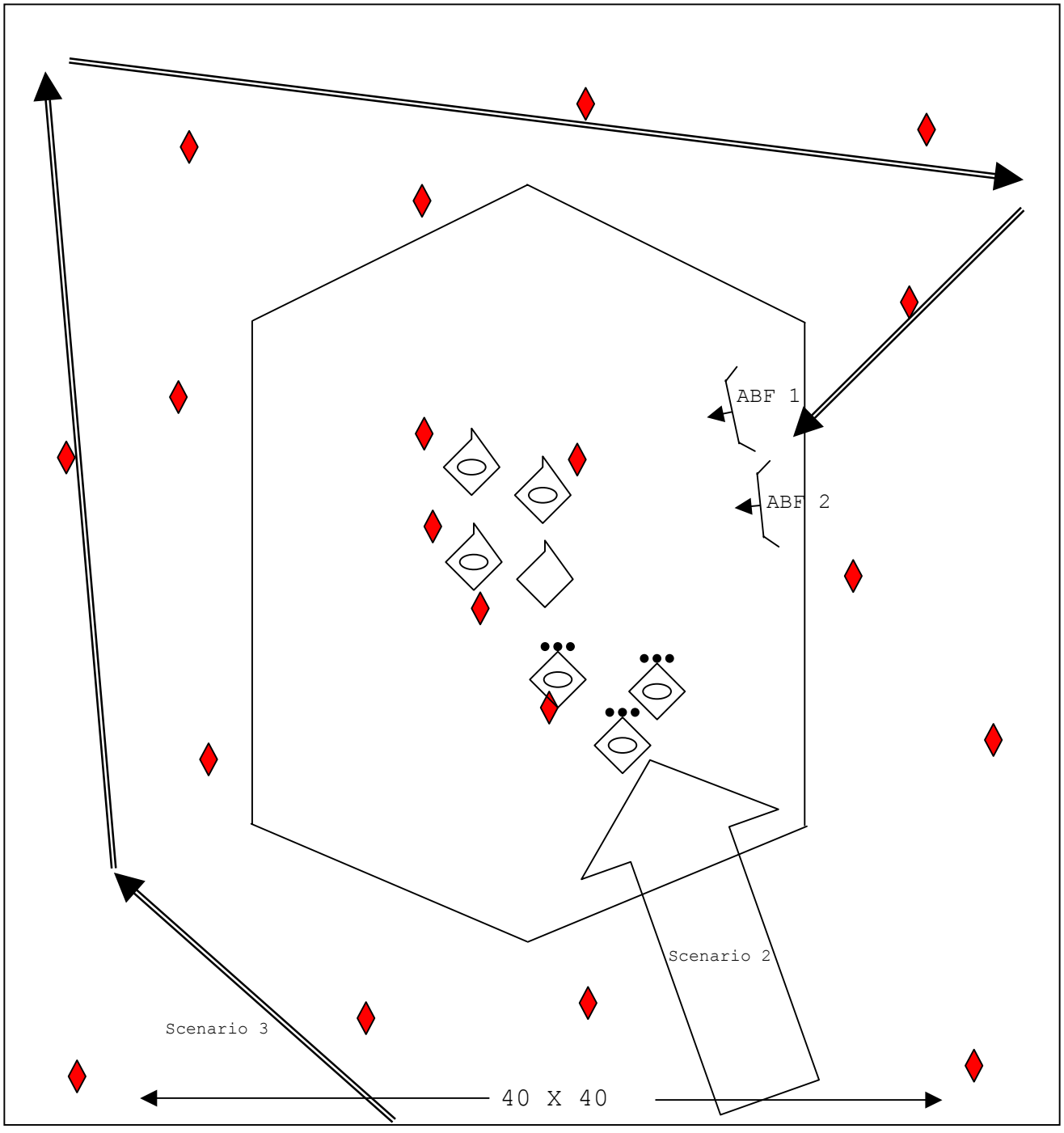

Figure 12. IOTE Layout

E. FOLLOW ON TEST AND EVALUATION (FOTE)

Items that may be tested during FOTE are those capabilities the aircraft will not have until the Block II aircraft are fielded in 2010. A critical capability to test in FOTE then is Battle Command on the Move. As detailed in the CONOPs section of Chapter II, Battle Command on the Move is one of the future missions the Comanche must be able to perform. Since the fielding schedule already indicates this capability will not be fielded until two years after IOTE by the aircraft's current fielding schedule, FOTE must evaluate Battle Command on the Move. Additional items that should also be included in FOTE are capabilities planned to be included in IOTE but not fielded in time, and any capabilities that the aircraft did not perform well in IOTE.

F. SUMMARY

The scenarios analyzed in this chapter provide a comprehensive means to test and evaluate the Comanche. Although there are several similarities in terms of MOPs/capabilities tested in each scenario, the scenarios were developed individually to test the critical

capabilities the Comanche must possess. However, if resources, primarily time or funding, become constrained, the scenarios can be combined. Done correctly, maintaining the realistic operational focus of the individual scenarios, combined scenarios will provide ample test and evaluation data to make an informed IOTE decision. Another method to conserve resources is to layout the IOTE in such a way that test instrumentation does not need to be moved and revalidated. Follow on Test and Evaluation should focus on FCS capabilities not able to be tested, or capabilities that were deficient in IOTE.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSION

The Army is embarking on drastic changes that affect the entire organization. As the Army develops the Future Combat Systems, care must be given to ensure the systems developed and fielded meet the needs of the objective force. IOTE plays a crucial part in this process.

Current documents, which form the basis for IOTE, do not delineate all the requirements and measures of performance necessary to determine if the Comanche meets the needs of the user. Only the Operational Requirements Document (ORD), and the Test and Evaluation Master Plan (TEMP) have been updated, but are still in draft form. The dendritics and the OPMODSUM have not been updated. In its present state, the OPMODSUM does not support end-to-end Future Combat Systems operations, focusing on the Comanche integrating into current legacy doctrine.

The IOTE must model the Future Combat System requirements to the greatest extent possible. Four basic scenarios suffice to evaluate the Comanche's ability to meet FCS requirements, based upon the Block-fielding

schedule of the aircraft. The future CONOP that cannot be evaluated in IOTE is Battle Command on the Move (BCOTM). This capability will not be fielded until 2010, with Block II aircraft. Follow on Test and Evaluation must be planned and executed as soon as simulation and fielding plans allow the system to be evaluated against the BCOTM requirements.

Ideally, all the scenarios will be run redundantly in as many different operating conditions as possible to provide complete data for evaluation. However, the resources required for such extensive testing makes this unrealistic. Obtaining sufficient data to make an IOTE decision should be possible and affordable using combined scenarios, reduced test iterations and well planned test monitoring.

B. RECOMMENDATIONS

1. Model IOTE Scenarios After FCS Missions

To accurately assess the Comanche's ability to perform as an integral member of the Army team over the next quarter century, the aircraft must be tested and evaluated in the context of expected missions during the same period.

This assessment mandates a change to the requirements to include non-Army units. In addition to internal Army components and systems, the Comanche must interoperate with other joint elements to an unprecedented level. One of Comanche's great tactical advantages is its ability to integrate and synthesize information from the entire air-ground team. To accurately assess this capability, all team members must take part in the IOTE.

2. Combine Scenarios

If resource shortfalls limit the number of scenarios that can be evaluated, combine scenarios. This combination must be done while maintaining the ability to test the key capabilities that the Comanche must perform. Taking operational shortcuts to save time and/or money in the testing process can skew data. To limit the effect of reduced testing, testers must focus on keeping the test operationally sound. Keeping the IOTE operationally sound provides accurate test results due to users accomplishing the missions as they have been trained, placing the aircraft in situations likely to be experienced in war.

3. Update the Operational Mode Summary

The current Comanche OPMODSUM does not reflect the Army's migration to the FCS. Although all of the vignettes in the current OPMODSUM reflect aspects of the missions required by the FCS, none of them encompass the complete set of requirements outlined in the CONOPs. The OPMODSUM must be updated to include all requirements the Comanche must perform as part of the FCS.

4. Layout the Test to Maximize Resources

IOTE test setup, is resource intensive. Each of the systems used to detect/measure test events incur time and money costs. The associated test equipment requires money expenditures to acquire for the test, and time expenditures to set up and validate before conducting the test. Moving this equipment between test events incurs additional costs, due to the cost of transit time. Any additional time required to conduct IOTE quickly adds up to significant expense when range time, equipment rental, maintenance, meals, lodging, and numerous other costs are factored in. Therefore, minimizing the time required to complete IOTE

leads to significant savings. An additional benefit of minimizing the time required for IOTE is less burden on program schedule. Positioning test equipment and measuring devices with minimal movement requirements, saves significant resources.

C. SUGGESTED FURTHER STUDIES

The RAH-66 IOTE is currently scheduled for the spring of 2008. Until that time, aircraft capabilities, and their associated timetable for inclusion, will undoubtedly change. In fact, the Comanche program has just undergone a complete rescheduling at the end of 2001, in which the program added two years to the timetable. This rebaseline also included the introduction of Blocking aircraft production. Blocking allows for aircraft to be fielded with different capabilities as the technology, or the ability to incorporate it into the aircraft, matures. Also during the time up to the Comanche IOTE, other systems that will comprise the FCS will be designed and perhaps fielded. To the greatest degree possible, those systems that will interact with the Comanche must be included in the IOTE.

Further and continuous study must be given to keep the IOTE applicable and current in relation to the FCS. If the program schedule slides again, or capabilities within the aircraft are fielded at a different pace than anticipated, the IOTE must change to reflect this. One of the key capabilities that must be investigated is the Comanche's ability to perform Battle Command on the Move. This capability is scheduled to be included in the aircraft in 2010, with the fielding of the Block II aircraft.

APPENDIX A. EXECUTION MATRIX FOR RECON TO MOBILE STRIKE

TIME	H-HOUR – H+25	H+25 – H1+10	H1+10 – H1+55	H1+55 – H2+40	H2+40 – H3+05	
EVENT	ACT crosses FLOT – enroute to zone	SWTs begin zone recon, DID ADA system	SWT DID TEL, ADA system	SWT DID TEL, ADA system	ACT redeploys to Assembly Area	DID= detect, identify, destroy
THREAT	Radar and IR ADA systems (STAR)	→	→	→	→	
MOPs	**All MOP 1-1-1-X** **All MOP 1-1-2-X** *limited # of targets All MOP 1-1-3-X *limited commo with external units.	**All MOP 1-1-1-X** **All MOP 1-1-2-X** *limited # of targets All MOP 1-1-3-X *limited commo with external units. **MOP 1-1-4-5; 1-1-4-7; 1-1-4-8** **Focus on MOP 1-1-3-6; 1-1-3-7**	**All MOP 1-1-1-X** **All MOP 1-1-2-X** *limited # of targets All MOP 1-1-3-X *limited commo with external units. **MOP 1-1-4-6; 1-1-4-7; 1-1-4-8** →	**All MOP 1-1-1-X** **All MOP 1-1-2-X** *limited # of targets All MOP 1-1-3-X *limited commo with external units. All MOP 1-1-4-X Except 1-1-4-6; utilizing OTTIS for engagements →	**All MOP 1-1-1-X** **All MOP 1-1-2-X** *limited # of targets All MOP 1-1-3-1 to 1-1-3-5 *limited commo with external units. →	
DESCRIPTION	ACT flies low and fast to the zone. Enroute the aircraft must evade both radar and IR seeking ADA systems. Aircraft systems must provide ample warning to allow the crew to modify flight route or take other necessary actions. Several threat systems are placed along the 100km route. ACT reports each checkpoint by voice, as well as being automatically tracked via links.	ACT breaks into SWTs to conduct zone recon. SWTs must utilize UAVs and JSTARS to cover the entire zone. Aircraft must detect enemy ADA and TEL systems prior to enemy engaging friendly aircraft. SWTs utilize non-organic fires to destroy targets. SWTs report each PL digitally and by voice.	SWTs must move and communicate quickly to cover whole zone, UAV and JSTAR links remain critical. SWTs will be forced to cover large frontages, stressing communication between elements. Comanche MEP critical in maintaining situational awareness. Threat systems begin using obscurants to defeat sensors/weapons. Conduct JAAT to destroy targets.	SWTs continue to maneuver through zone. Last target set must be placed deep in zone to stress Comanche station time. JAAT aircraft no longer on station, friendly artillery cannot range last targets. SWTs conduct direct fire engagements to destroy final TEL and ADA.	Utilizing different routes, SWTs maneuver back through zone to linkup point; ACT returns to Assembly Area to prepare for future missions.	
This scenario, more than any other, stresses the Comanche's ability to meet its flying speed, auxiliary fuel, BLOS/NLOS communication, Low Observability, off-board sensor integration, and joint engagement requirements. Although almost all MOPs can be tested and evaluated, the limited number of targets will not stress the Comanche's ability to observe, acquire and prioritize targets in various battlefield conditions to the extent of other scenarios. Likewise, the Comanche's ability to communicate with external organizations is tested to a limited extent. This scenario does not examine air-ground interoperability.						

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APPENDIX B. EXECUTION MATRIX FOR CLOSE COMBAT WITH GROUND FORCES

TIME	H-hour – H+1	H+1 – H+2	H+2 – H+3	H+3 –	
EVENT	LD to destruction of enemy recon	Contact w/ company size element	Contact w/ BN size element	Screen established on LOA	LD=Line of departure
THREAT	Platoon and smaller recon w/ IR SAMs	Company size element with radar guided ADA	Battalion Size element w/ radar and IR ADA	Remnants	
MOPs	All MOP 1-1-1-X **All MOP 1-1-2-X** All MOP 1-1-3-1 to 1-1-3-5 **All MOP 1-1-4-X** Except 1-1-4-6; utilizing OTTIS for engagements	All MOP 1-1-1-X **All MOP 1-1-2-X** All MOP 1-1-3-1 to 1-1-3-5 **All MOP 1-1-4-X** Except 1-1-4-6; utilizing OTTIS for engagements	All MOP 1-1-1-X **All MOP 1-1-2-X** Extensive targets All MOP 1-1-3-1 to 1-1-3-5 All MOP 1-1-4-X	All MOP 1-1-1-X All MOP 1-1-2-X All MOP 1-1-3-1 to 1-1-3-5 **All MOP 1-1-4-X** Except 1-1-4-6; utilizing OTTIS for engagements	
DESCRIPTION	ACT conducts zone reconnaissance ahead of the GCTs to facilitate their rapid movement. ACT destroys enemy reconnaissance, blinding the enemy to the squadron's maneuver. ACT continues to press forward until making contact with enemies leading company sized element. ACT maintains contact and provides GCT situational awareness to best engage and destroy enemy forces.	ACT maintains contact with the enemy, focusing deep to provide early warning as new enemy forces push forward to engage the squadron. ACT destroys enemy ADA upon detection. Second in priority of targets is enemy armor. SWTs conduct relief on station, rotating back to the FARP. Prior to rotating back to the FARP, ACT engages targets of opportunity. ACT maintains priority of indirect fires throughout.	Squadron continues to press to LOA, ACT maintaining reconnaissance forward. ACT continues to destroy high value targets with direct and indirect fires, handing other targets off to GCTs. ACT also conducts JAAT at prescribed time. ACT continues FARP rotation as necessary. Extensive obscurants and chemical agents present on the battlefield.	Once squadron reaches LOA, ACT screens forward of GCTs providing early warning, reaction time and maneuver space. Once GCTs set in defense, ACT reconsolidates to prepare for future operations.	LOA=Limit of Advance
This scenario focuses on air-ground interoperability. Maintaining situational awareness during rapid joint air-ground maneuver, especially with heavy enemy contact, is extremely difficult. The Comanche MEP must assimilate and share necessary information between all team members, helping to build an accurate common operating picture. Accurate information sharing becomes more critical as SWTs rotate into and out of the FARP. Total situational awareness must be maintained to prevent loss of aircraft, or loss of enemy contact. Comanche sensors must detect, identify and destroy enemy forces at extended ranges.					

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APPENDIX C. EXECUTION MATRIX FOR MOBILE STRIKE

TIME	H-HOUR – H+15	H+15 – H+35	H+35 – H1+25	H1+25 – H1+45	H1+45 –	
EVENT	ATKHC crosses FLOT – enroute to BPs	ATKHC arrives BPs; begin engagements	ATKHC displaces to FARP/return BPs	ATKHC arrives BPs; begin engagements	ATKHC redeploys to Assembly Area	
THREAT	Radar and IR ADA systems (STAR) →	Armor BN+		Armor BN-	→	
MOPs	All MOP 1-1-1-X **All MOP 1-1-2-X** All MOP 1-1-3-X *limited commo with external units. **Focus on MOP 1-1-3-6; 1-1-3-7** →	All MOP 1-1-1-X **All MOP 1-1-2-X** extensive # and types of targets All MOP 1-1-3-X *limited commo with external units. **All MOP 1-1-4-X;** *except 1-1-4-6	All MOP 1-1-1-X All MOP 1-1-3-X *limited commo with external units.	All MOP 1-1-1-X **All MOP 1-1-2-X** extensive # and types of targets All MOP 1-1-3-X *limited commo with external units. **All MOP 1-1-4-X;** *except 1-1-4-6	All MOP 1-1-1-X All MOP 1-1-3-X *limited commo with external units. →	
DESCRIPTION	ATKHC flies low and fast to the ABFs. Enroute the aircraft must evade both radar and IR seeking ADA systems. Aircraft systems must provide ample warning to allow the crew to modify flight route or take other necessary actions. Several threat systems are placed along the 100km route. ATKHC verifies target location enroute through UAVs and JSTARs.	ATKHC breaks into PLTs to occupy ABFs. Aircraft detect enemy vehicles and engage in priority; ADA, armor, command and control, miscellaneous. While in BPs enemy aircraft detected and fired upon. ATKHC calls for indirect fire to cover their egress.	While enroute, in the FARP, and returning from the FARP, ATKHC maintains situational awareness through UAVs and JSTARs.	ATKHC occupies alternate ABFs and resumes attack. Heavy obscurants conceal the EA from eye view. ATKHC must differentiate between viable targets, and targets already serviced. The attack continues until the ATKHC has expended all ordnance or has no more viable targets.	Using different route, ATKHC egresses back to Assembly Area to prepare for future missions.	EA=Engagement Area
This scenario focuses on the Comanche's lethality in a target rich environment. Utilizing it's advanced systems, the aircraft should be able to quickly maneuver to a firing position, scan for targets, prioritize, and then assign targets to the entire team of Comanches. Engagements should be quick and deadly, with all aircraft firing near simultaneously. This scenario also tests the aircrafts ability to not only discern different types of vehicles through heavy obscurants, but also its ability to verify BDA.						

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APPENDIX D. EXECUTION MATRIX FOR MULTI-MODAL OPERATIONAL MANEUVER

TIME	H-hour – H+1	H+1 – H+2	H+2 – H+3	H+3 – H+4	
EVENT	Maneuver through breach; zone recon	Zone recon; hasty attack w/ GCT	Establish screen	Conduct hasty attack; AA Ops	
THREAT	Isolated PLTs or smaller	Armor company and ADA systems		Armor company and ADA systems	
MOPs	All MOP 1-1-1-X **All MOP 1-1-2-X** All MOP 1-1-3-X	All MOP 1-1-1-X **All MOP 1-1-2-X** All MOP 1-1-3-X **All MOP 1-1-4-X;** *except 1-1-4-6	All MOP 1-1-1-X *(All MOP 1-1-2-X) All MOP 1-1-3-X ***(All MOP 1-1-4-X)**	All MOP 1-1-1-X **All MOP 1-1-2-X** extensive # and types of targets All MOP 1-1-3-X extensive commo with external units. **All MOP 1-1-4-X;** *except 1-1-4-6	
DESCRIPTION	PLT from ACT leads squadron through the breach, maintaining contact with friendly units on the squadron's flank as it pushes forward. ACT conducts zone reconnaissance to the squadron's front, allowing rapid movement of the GCTs. Comanches destroy squad sized units or smaller, handing off larger units to GCTs. ACT assigned priority of fire within the squadron.	As the squadron maneuvers to its blocking positions, it encounters an enemy armor company pushing forward to the breach. The air PLT provides early warning and conducts target handover to GCTs, after destroying ADA systems accompanying the armor.	ACT establishes screen along air LOA, GCTs establish hasty defense along ground LOA. ACT focuses on long range acquisition of any approaching enemy. ACT retains priority of fire for the squadron, to include four sorties of CAS. *(Test can run more threat at the screening forces, to further evaluate target acquisition and Comanche integration with CAS.)	After screen is established, the division directs the squadron to provide a PLT of Comanches to conduct a hasty attack to destroy enemy positions delaying the BCT. The PLT receives a fragmentary order to return to the FARP, load hellfire missiles, and execute the hasty attack. Upon the completion of the hasty attack, the ACT conducting operations is directed to return to the AA.	CAS=Close Air Support
This scenario tests the Comanche's ability to work with several different maneuver units operating in close proximity on the battlefield. The aircraft must be able to differentiate between friendly organizational, non-organizational and enemy vehicles. The common operating picture must be accurate enough to allow the squadron's aircraft to be given a new mission, with another ground element, without having to spend an inordinate amount of time on the radio or conducting a face-to-face meeting. Further, as teams rotate to and from the FARP, the Comanche's systems must develop and sustain a common operating picture that allows quick assumption of the duties left by the departing team.					

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